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BOEING

19 March 2002
C6-BRC-T-02-004

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

Attention: John Geroch

Subject: **SOIL INVESTIGATION, SHALLOW SOIL REMEDIATION, AND SCREENING LEVEL RISK ASSESSMENT FOR BOEING REALTY CORPORATION, FORMER C-6 FACILITY, 19503 SOUTH NORMANDIE AVENUE, LOS ANGELES, CA**

Dear Mr. Geroch:

Please find enclosed for your review, two copies of the subject document prepared by Haley & Aldrich for Boeing Realty Corporation.

If you have any questions concerning this document, please contact the undersigned at 562-593-8623.

Sincerely,

Stephanie Sibbett

Stephanie Sibbett
Boeing Realty Corporation

Cc: Mario Stavale, Boeing Realty Corporation

enclosure

SOIL INVESTIGATION,
SHALLOW SOIL REMEDIATION, AND
SCREENING-LEVEL RISK ASSESSMENT

BOEING REALTY CORPORATION
FORMER C-6 FACILITY, PARCEL C
LOS ANGELES, CALIFORNIA

March 13, 2002

SOIL INVESTIGATION,
SHALLOW SOIL REMEDIATION, AND
SCREENING LEVEL RISK ASSESSMENT

BOEING REALTY CORPORATION
FORMER C-6 FACILITY, PARCEL C
LOS ANGELES, CALIFORNIA

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LIST OF ABBREVIATIONS AND ACRONYMS

ARB	Air Resources Board
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BRC	Boeing Realty Corporation
CEM	Conceptual Evaluation Model
cis-1,2-DCE	cis-1,2-dichloroethene
COPC	Chemical of potential concern
cy	Cubic yard
DAC	Douglas Aircraft Company
DAF	Dilution attenuation factor
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
DTSC	Department of Toxic Substances Control
DWR	(California) Department of Water Resources
EDD	Electronic data deliverable
EF	Environmental Feature
ESA	Environmental Site Assessment
FAL	Field Action Level
HASP	Health and Safety Plan
IDW	Investigation-derived waste
ILM	Industrial Light Metals
LARWQCB	California Regional Water Quality Control Board, Los Angeles Region
LBF	Lower Bellflower Aquitard
µg/L	Micrograms per liter (parts per billion)
MBFM	Middle Bellflower Mud
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram (parts per million)
msl	Mean sea level
PAH	Polynuclear aromatic hydrocarbon
QA/QC	Quality Assurance/Quality Control
OEHHA	Office of Environmental Health Hazard Assessment
PCBs	Polychlorinated biphenols
PCE	Tetrachloroethene
PID	Photoionization detector
PRG	Preliminary Remediation Goal
PRP	Potentially responsible party
REL	Reference Exposure Level
RAWP	Risk Assessment Work Plan

RME	Reasonable Maximum Exposure
SAP	Sample and Analysis Plan
SGSC	Soil Gas Screening Concentrations
SRA	Screening-level risk assessment
SSL	Soil Screening Level
STL	Severn Trent Laboratories, Inc.
SWMP	Soil and Waste Management Plan
SVE	Soil Vapor Extraction
SVOC	Semi-volatile organic compound
1,1,1-TCA	1,1,1-trichloroethane
TCE	Trichloroethene
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TRPH	Total recoverable petroleum hydrocarbon
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground storage tank
VOC	Volatile organic compound

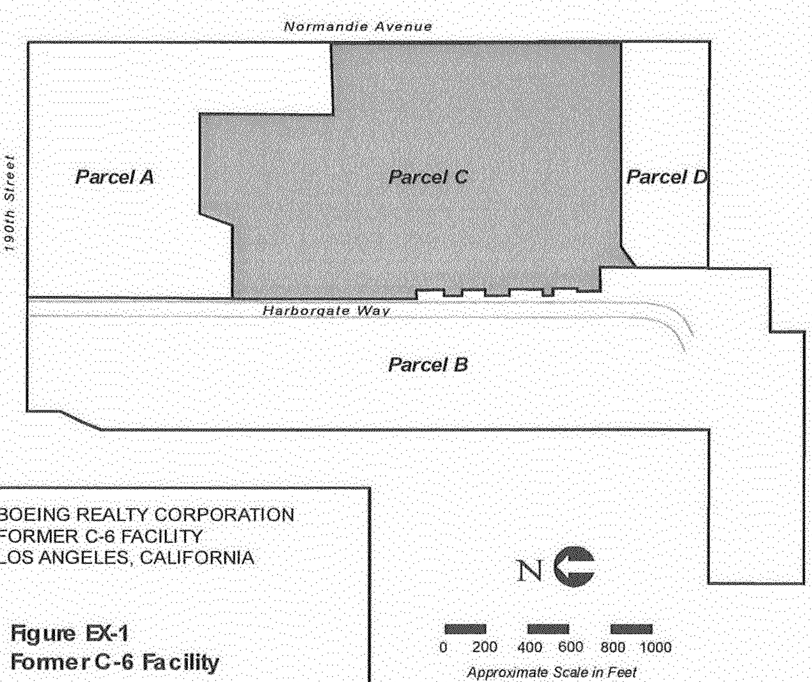
EXECUTIVE SUMMARY

Boeing Realty Corporation (BRC) is redeveloping the 170-acre Former C-6 Facility in Los Angeles, California (Facility). As part of the redevelopment, the Facility was divided into four parcels (Figure EX-1). Parcels A, B and D were the focus of previous investigations and these parcels have been sold. The subject of this report, Parcel C, is still owned by BRC. It occupies approximately 50.5 acres in the east-central portion of the Facility. Although now demolished and removed, there were previously 12 structures occupying Parcel C, ranging in size from a 7,500 square foot security office to a 1,000,000 square foot aircraft manufacturing and assembly building.

The purpose of this project was to prepare Parcel C for redevelopment by:

1. identifying and delineating the extent of impacted soil,

2. evaluating risks to human health and groundwater associated with the impacted soil and groundwater,



HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

BOEING REALTY CORPORATION
FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

Figure EX-1
Former C-6 Facility

3. removing shallow occurrences of impacted soil, and

4. initiating plans for remediation of deep soil and groundwater.

Under the oversight of the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB), the investigation focused on 233 environmental features (EFs) identified as being of potential concern during a review of historical operations. The EFs included such facilities as paint booths, degreasers, chemical storage areas, underground storage tanks (USTs), sumps, clarifiers and machining areas. In addition, this investigation addressed "open areas" such as paved parking lots and large interior spaces, where no EFs had been identified, to minimize the potential for discovery of unanticipated impacted soils during redevelopment of Parcel C.

The Facility is surrounded by properties with documented environmental impacts: the Del Amo Superfund site is located to the east of Parcel C; the Montrose Superfund site is to the south; and the Industrial Light Metals (ILM) site is located to the west. Established potentially responsible party (PRP) groups are addressing environmental issues at these sites under the oversight of either the U.S. Environmental Protection Agency (USEPA) or California Department of Toxic Substances Control (DTSC). There is evidence of some groundwater impacts having migrated onto Parcel C from off-site sources. In particular, benzene from the Del Amo site and chlorobenzene from the Montrose site both appear to have encroached on the southeastern corner of Parcel C.

PROJECT APPROACH

The overall objectives of this investigation were to:

- Identify and delineate areas in which vadose zone soil has been impacted by organic and/or inorganic compounds used at the Facility;

- Evaluate potential impacts to human health and threat to groundwater quality;

- Remediate soil impacts to Office of Environmental Health Hazard Assessment (OEHHA)-approved risk levels.

The EFs and open areas were investigated by analyzing soil gas and soil samples collected from soil gas probes, direct-push borings and hollow-stem auger drilling methods. The soil gas samples were analyzed for volatile organic compounds (VOCs), and the soil samples were analyzed for a suite of organic and inorganic parameters selected based on the nature of the nearby former manufacturing or support operations. The specific investigative approach for each EF is presented in the Sampling and Analysis Plan (SAP) and its supplements (Kennedy/Jenks, 2000a; 2000b; Ogden, 2000a; Haley & Aldrich, 2001a; 2001b). As the results of the analyses were received from the analytical laboratories, they were evaluated and compared to soil gas screening concentrations (SGSCs) or soil field action levels (FALs). FALs and SGSCs are health and environmental risk-based values that were developed as tools for delineating soil impacts. Specifically, if a soil gas or soil sample contained a constituent at a concentration above the corresponding SGSC or soil FAL, then the area was re-evaluated to assess the need for additional "step-out/step-down" data points.

Screening-level risk assessment (SRA) calculations were then conducted to evaluate potential human health risk associated with the organic and inorganic compounds identified in soil. The SRA calculations also addressed potential risks related to upward vapor migration from impacted groundwater. The SRA was based on conservative exposure scenarios and assumptions regarding the chemical concentrations to which potential receptors may be exposed. The SRA was designed to be conservative so that further evaluation or remedial action would not be required as long as the results indicated that the concentrations of compounds identified in the subsurface do not exceed the OEHHA-approved risk levels. Shallow soil impacts that contributed significantly to overall risk and potential groundwater impact were excavated. Deep soil impacts will be addressed as part of the site-wide groundwater program. After site characterization, demolition, remedial excavation, and grading activities were concluded, the SRA was performed to assess the human health risk associated with the residual soil concentrations.

INVESTIGATION RESULTS

Parcel C has been extensively investigated for subsurface impacts: approximately 5,900 soil samples were collected from over 1,200 distinct locations. This total includes samples collected from soil borings and post-demolition investigation confirmation activities. Soil samples were collected from the surface to depths of 65 feet, which is the approximate depth of the water table. A total of 169 soil gas samples were also collected at the site.

Soil Stratigraphy. The top 110 to 150 feet of sediment at the Facility is part of the Bellflower Aquitard. Soil in the upper 20 to 50 feet consists predominantly of silts and clays. This fine-grained zone increases in thickness to the east. An east-dipping sandy zone underlies the fine-grained shallow soils. This sandy zone is generally 80 to 100 feet thick and is interbedded with numerous continuous and discontinuous layers of finer-grained sediments. The sandy unit is underlain by another fine-grained zone at a depth of approximately 110 to 120 feet below ground surface (bgs).

Shallow Soil Results (0 to 12 feet bgs). Based on the analytical results of soil and soil gas samples collected during the current and previous investigations and the results of the SRA calculations, 34 locations of shallow soil impact were identified. The identified areas exceeding OEHHA-approved risk levels were remediated by excavation.

Deep Soil Results. There were three primary occurrences of soil impact that extended into deeper soil (between 12 and 65 feet). The Knox Street Right-of-Way included petroleum hydrocarbons to a depth of approximately 26 feet and was remediated by excavation. The other

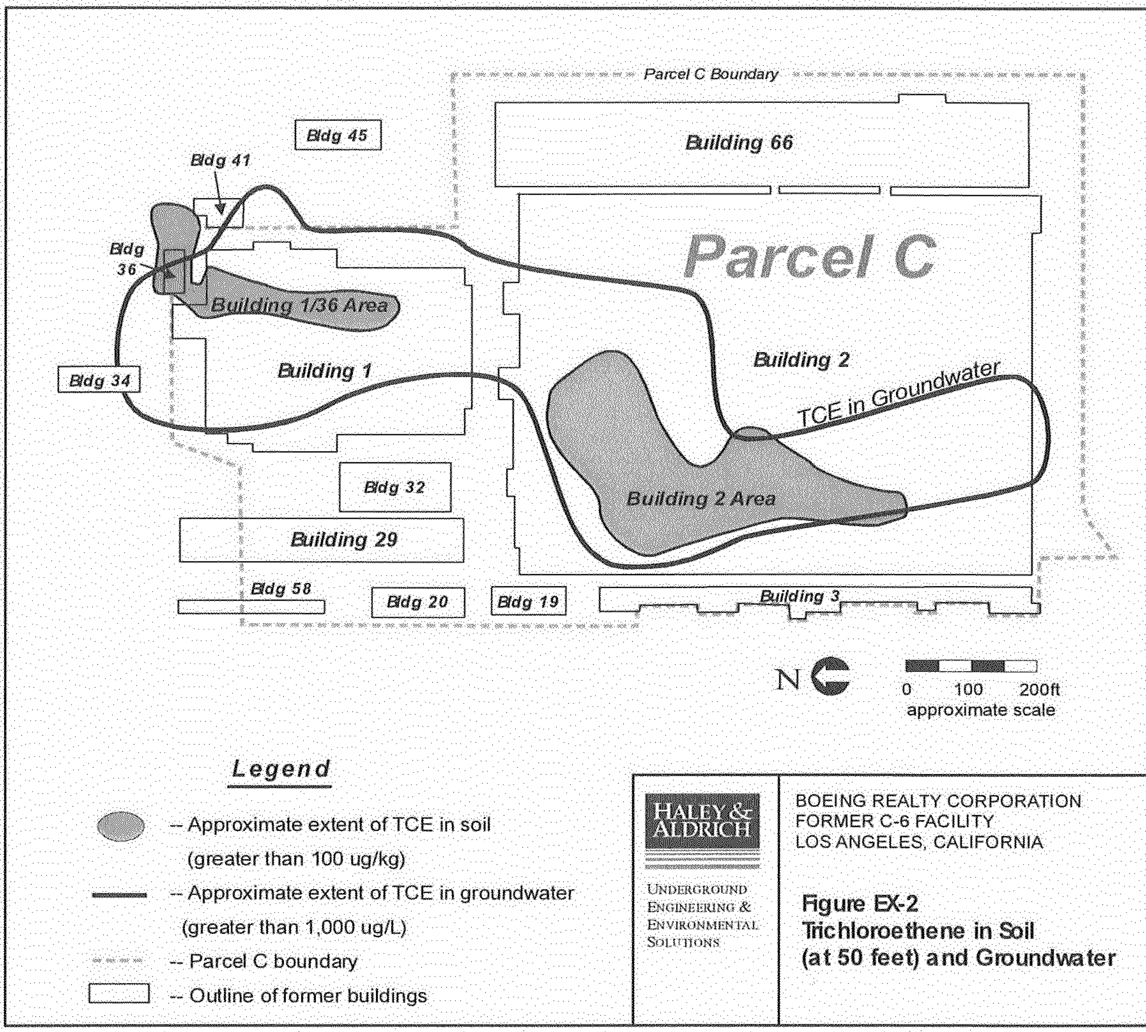


Figure EX-2
Trichloroethene in Soil (at 50 feet) and Groundwater

two occurrences of deep soil impact are referred to as the "Building 1/36 area" and the "Building 2 area" (see Figure EX-2). These two areas include VOCs to a depth of approximately 65 feet bgs. These areas will be remediated by soil vapor extraction (SVE). The upper 12 feet of both the Building 1/36 and the Building 2 areas have already been remediated by excavation.

Correlation between Soil and Groundwater Impact

Groundwater quality has been characterized by 43 monitoring wells and 41 hydropunch locations, which were previously installed at strategic locations across the Facility. Figure EX-2 compares the location and extent of deep soil impact with the 1,000 µg/L trichloroethene (TCE) groundwater contour. There is a good spatial correlation between groundwater impacts and areas of deep TCE impact in vadose zone soil. Comparisons of the distribution of toluene and 1,1,1-trichloroethane (1,1,1-TCA) also show good spatial correlation between soil and groundwater. This suggests that the primary source areas contributing to VOC groundwater impacts have been identified. Complete results of the groundwater investigation will be presented in a separate report, although a summary of the groundwater findings are presented in Section 6 of this report.

SCREENING-LEVEL HUMAN HEALTH RISK ASSESSMENT

Haley & Aldrich used a SRA approach during the investigation activities and after completion of site characterization, site demolition, remedial excavation, remediation confirmation sampling, and site grading. The objective of the SRA was to provide a conservative indication of risk to human health from potential exposure to site-related chemicals of potential concern (COPCs) in soil and groundwater beneath Parcel C. The SRA was conducted in accordance with the OEHHA-approved Risk Assessment Work Plan (RAWP) and its addenda (Ogden, 2000 and Haley & Aldrich, 2001).

During the investigation activities, SRA calculations were used to evaluate soil and groundwater data obtained as the investigation was proceeding to ensure that there would be no significant human health risks associated with potential exposures to site-related chemicals. Based on SRA calculations conducted during the investigation activities, several areas of Parcel C contained chemical concentrations that would result in risks greater than the OEHHA-approved risk levels. The SRA calculations were used to assess the extent of soil remediation that would be necessary to lower the associated risks to less than the OEHHA-approved risk levels. After excavation activities, SRA calculations were conducted using the confirmation samples to verify that no further excavation was necessary.

After site characterization, demolition and remedial excavation activities were completed, remediation confirmation samples were collected, and grading activities were concluded, the SRA was performed to assess whether the soil remediation was sufficient and to assess risk associated with potential exposures from existing conditions. The SRA was designed to be conservative so that no further risk assessment or remedial action would be required to protect human health (i.e., the calculated risks for existing conditions are less than OEHHA-approved risk levels). The completed SRA is presented in Appendix A and indicates that for a future commercial/industrial land use scenario, the estimated excess lifetime cancer risk is approximately 50% lower than the OEHHA-approved risk level, and the total hazard index for noncarcinogenic effects is almost 10% below the OEHHA-approved hazard index. Concentrations of lead, evaluated using the DTSC LEADSPREAD model, are also below the OEHHA-approved risk levels.

Haley & Aldrich also evaluated whether impacts in shallow (within the upper 12 feet bgs) soils had the potential to degrade groundwater quality. Deeper soil is being addressed as part of the site-wide groundwater program. The maximum chemical concentrations in soil were compared to site-specific soil screening levels (SSLs) derived from primary or secondary maximum contaminant levels (MCLs). Results of this evaluation indicated that groundwater impacts will not occur based on the residual concentrations present in shallow soil. As a result, no further investigation or remediation is needed for shallow soils in Parcel C.

SHALLOW SOIL REMEDIATION

Based on the results of the soil investigation, SRA calculations, and groundwater protection evaluation, approximately 14,200 cubic yards of impacted soil were excavated from 34 locations on Parcel C. The soil excavations on Parcel C are shown on Figure EX-3. Table EX-1 summarizes the number of excavations and approximate volumes of excavated soil.

Soil impacts were removed during or immediately after demolition of the buildings. If impacts were detected, SRA calculations were conducted to assess the potential risk to human health and potential threat to groundwater quality. If concentrations were not considered acceptable, the impacted area was scheduled for excavation.

For each excavation, confirmation soil samples were collected to verify that the impacted soil had been sufficiently addressed. SRA calculations and a groundwater protection evaluation were again conducted for the confirmation sample data to assess the need for additional excavation. Excavated soil was stockpiled temporarily on-site. Based on the sample results, stockpiled soil was either placed back on the property or disposed of off-site.

Table EX-1: Summary of Shallow Soil Excavations

Building*	Number of Excavations	Compounds Present	Approximate Volume of Soil Excavated
Building 1	7	VOCs, TPH, inorganics, PAHs	10,000 cy
Building 2	21	VOCs, TPH, inorganics, PCBs, PAHs	3,800 cy
Building 3	2	TPH, inorganics	10 cy
Building 20	1	TPH, inorganics, PAHs	200 cy
Building 32	2	VOCs, inorganics	100 cy
Building 66	1	inorganics	50 cy

**Includes excavations in or near former buildings*
cy = cubic yard
PCB = Polychlorinated biphenols
PAH = Polynuclear aromatic hydrocarbon

DEEP SOIL REMEDIATION

Excavation of deep soils was conducted in two areas: the Knox Street Right-of-Way and the area in the immediate vicinity of the Building 2 clarifiers (labeled, "T-20" on Figure EX-3). In each area, shallow soil excavations were deepened to the limits of the excavation equipment (typically 26 feet bgs). Approximately 5,000 cubic yards of soil were removed from the Knox Street Right-of-Way and approximately 1,300 cubic yards of soil were removed from the T-20 excavation.

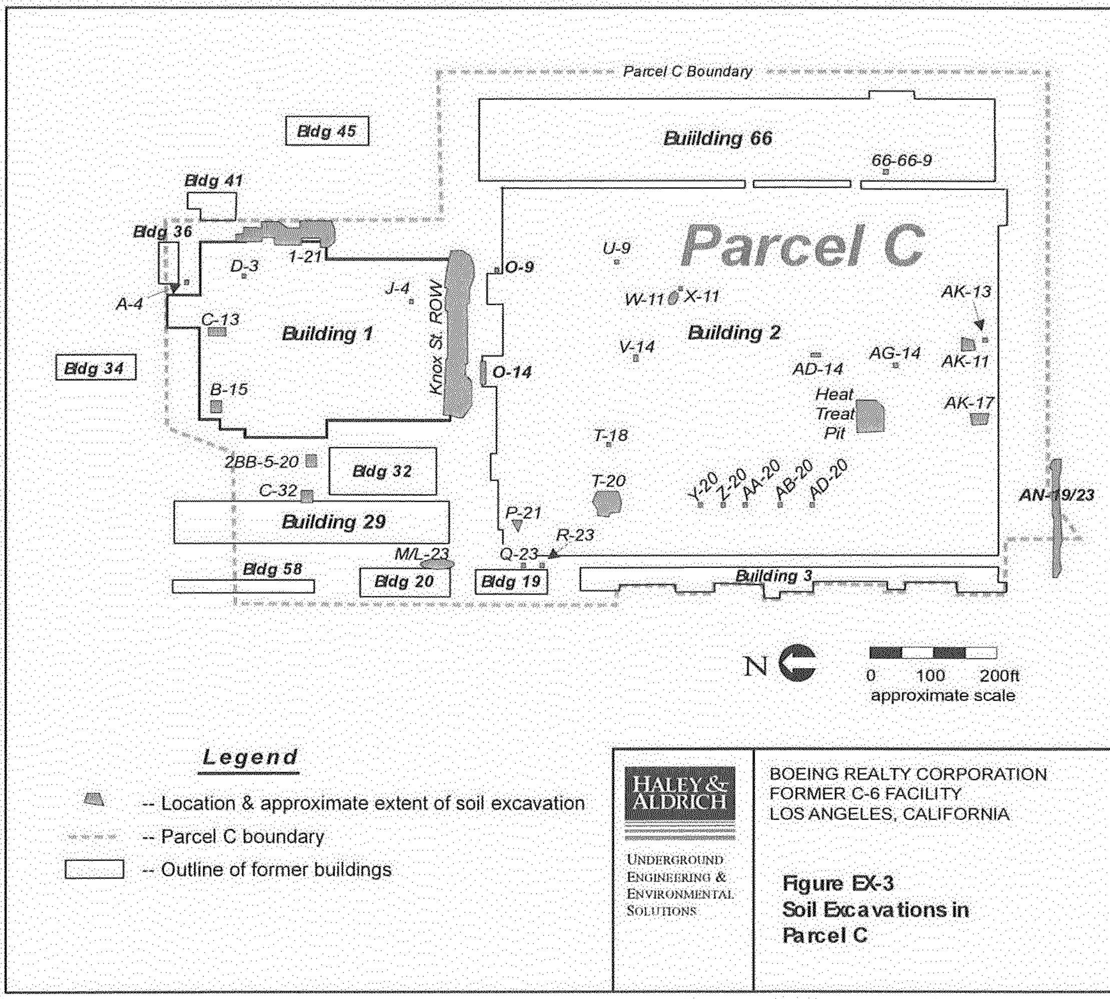


Figure EX-3
Soil Excavations in Parcel C

Two deep VOC soil impacts remain at Parcel C: the Building 1/36 and Building 2 areas (Figure EX-2). According to the SRA calculations, these areas do not pose a threat to human health, however they do constitute a potential risk to groundwater. Accordingly, VOC impacts in these areas are being remediated by SVE.

CONCLUSIONS

Key conclusions from this project are summarized below.

- Soil impacts within Parcel C have been delineated to evaluate the potential risks to human health and groundwater.

- Soil impacts were concentrated in five primary areas: VOCs in the Building 1/36 and Building 2 areas; TPH in the Knox Street Right-of-Way and the Heat Treat Pit; and arsenic along the east side of Building 1 (the 1-21 area).

- Other areas of impact in soil are present throughout Parcel C but are of relatively limited extent and low concentrations. The most common constituents in these scattered, impacted areas are petroleum hydrocarbons and VOCs, although some include inorganic compounds, PAHs, and PCBs.

- There is a good correlation between groundwater impacts and areas of high VOC concentrations and deep impact in vadose zone soil, indicating that the primary source areas contributing to VOC groundwater impact have been identified.

- Shallow soil impacts posing a risk above OEHHA-approved risk levels were remediated through excavation. Based on SRA calculations, approximately 14,200 cubic yards of soil were removed from 34 excavations.

- The SRA was performed after completion of site characterization, site demolition, remedial excavation, remediation confirmation sampling, and site grading to evaluate risks to human health posed by existing soil conditions at Parcel C. The results of the SRA indicate that no further remedial excavation activities are necessary to protect public health.

- Based on the SRA and the groundwater protection evaluation, shallow soil can be closed with no further investigation or remedial action.

- Deep soil VOC impacts in the Building 1/36 and Building 2 areas will be addressed through the implementation of SVE remediation.

- Groundwater impacts and other isolated occurrences of deep soil impact will be addressed as part of a site-wide groundwater program, which is currently under development.

In summary, Parcel C of BRC's Former C-6 Facility has undergone a comprehensive investigation through the collection and analysis of soil gas and soil samples at identified environmental targets and throughout the surrounding open areas. No additional soil investigation is necessary. Shallow soil impacts have been remediated and regulatory closure for shallow soil is warranted. Human health risk from potential exposure to existing conditions is below OEHHA-approved risk levels. Based on the results of this soil investigation and SRA, it is the professional opinion of Haley & Aldrich that Parcel C can be safely redeveloped for commercial or industrial use.

1.0 INTRODUCTION

Boeing Realty Corporation (BRC) is redeveloping Parcel C, which is a portion of the Former C-6 Facility (Facility) in Los Angeles, California. The other parcels of the Facility, Parcels A, B and D, were the focus of previous investigations and these parcels have been sold. The subject of this report, Parcel C, is still owned by BRC. It occupies approximately 50.5 acres in the east-central portion of the Facility. Located at 19503 South Normandie Avenue (Figure 1), the Facility is a former aircraft manufacturing facility.

BRC has demolished all of the buildings on the Former C-6 Facility. Having removed the existing structures and pavement, BRC has regraded the Parcel C property, installed new surface and subsurface infrastructure (streets, sewers, storm drains and utilities) and plans to sell, redevelop and/or lease the subdivided lots.

As part of the redevelopment process, BRC retained a multi-disciplinary team of environmental consultants to address subsurface environmental conditions beneath Parcel C under the oversight of the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB). The team includes Haley & Aldrich, Inc. and England Geosystem, Inc., who were responsible for completing a comprehensive subsurface investigation of vadose zone soil. Based on the results of the investigation, shallow occurrences of impacted soil were excavated, soil vapor extraction (SVE) pilot testing for remediation of deep soil was initiated, and a screening-level risk assessment (SRA) was completed. This report provides the results of the soil investigation, SRA, and remediation of shallow vadose zone soil at Parcel C.

The overall objectives of this environmental effort were to:

- Identify and delineate areas in which vadose zone soil has been impacted by organic and/or inorganic compounds used in Parcel C of the Facility;
- Evaluate potential impacts on human health and threat to groundwater quality;
- Remediate soil impacts to facilitate site closure and redevelopment.

The investigation program included collection and analysis of 169 soil gas samples and over 5,900 soil samples to evaluate the nature and extent of the subsurface impact on Parcel C. The investigation was conducted in accordance with a Sampling and Analysis Plan (SAP), dated August 16, 2000 (Kennedy/Jenks, 2000a), Addendum A to the SAP, dated September 12, 2000 (Kennedy/Jenks, 2000b), and three subsequent supplements[1]. The results of the investigation provided data necessary for an SRA, which, in turn, provided guidance for resolving shallow soil issues in Parcel C.

[1] Technical Memorandum No. 1 dated December 14, 2000 (Ogden, 2000a); Supplement No. 2 dated February 15, 2001 (Haley & Aldrich, 2001a); and Supplement No. 3 dated February 22, 2001 (Haley & Aldrich, 2001b).

1.1 OVERVIEW OF FORMER C-6 FACILITY

1.1.1 History of Former C-6 Facility

The Facility was first developed by the Defense Plant Corporation in 1941 as part of an aluminum production plant and was operated by the Aluminum Corporation of America until late 1944 (Camp, Dresser & McKee, 1991a). Aerial photographs indicate that the Facility property was farmland prior to the 1940s. From 1944 until 1948, the Facility property was used for warehousing by the War Assets Administration. In 1948, the Columbia Steel Company acquired the Facility. In March 1952, the U.S. Navy purchased the Facility and established Douglas Aircraft Company (DAC) as the contractor and operator of the Facility for the manufacture of aircraft and aircraft parts. DAC purchased the Facility from the Navy in 1970 (Camp, Dresser & McKee, 1991a); DAC and its successor, McDonnell Douglas Corporation (created by the 1967 merger of DAC and McDonnell Aircraft Company), owned and operated the Facility and continued manufacturing aircraft components until 1992. The Boeing Company took ownership of the Facility in 1997 when it merged with McDonnell Douglas Corporation.

Although most manufacturing operations ceased in 1992, a limited amount of assembly and warehousing continued through the mid-1990s. The Facility is currently closed, and the buildings have been demolished and removed from the property. Parcels A, B and D have been sold. Parcels A and B have been partially or fully redeveloped; Parcels C and D are currently vacant.

1.1.2 Description of Parcel C

Parcel C encompasses approximately 50.5 acres and included all or portions of twelve buildings as shown on Figure 2. The buildings important to this project are described below. Information presented in this section is based on a review of reports, drawings and photographs provided by BRC and observations made during site visits and demolition activities.

1.1.2.1 Building 1

Building 1 was an approximately 250,000 square foot structure used by DAC as a parts and records storage warehouse. The building was originally used as a carbon baking area when the Facility was an aluminum production plant. Other activities have included metal finishing processes such as heat treating, milling and pressing. Dip tanks were located in the western annex of the building. Floor patches on the first level and in the southwest corner of the Building 1 marked the location of several former drop hammer pits.

Historical drawings and aerial photographs from the 1940s to 1984 indicate that Building 1 was originally three free-standing structures separated by two enclosed patio areas. One patio reportedly housed emissions scrubbing and water treatment equipment. According to a 1952 demolition drawing, the patio areas had, at one time, included a smoke stack, a pump house and six underground storage tanks (USTs) that contained fuel.

A single-level, three-section basement was present under portions of Building 1. The basement was not part of the original construction and may have been added during renovations in 1952. The basement was reportedly used to store dies, molds and records. DAC personnel stated that the east wing of the basement was also used as a painting area. Kennedy/Jenks Consultants, Inc. (Kennedy/Jenks) sampled accessible areas in the basement in 1997 and reported the results in 2000 (Kennedy/Jenks, 2000c).

During demolition, a network of concrete structures was discovered beneath the foundation slab of Building 1. It is suspected that the cooling basins were used in the aluminum production process. The structures were located along the northern and southern sides of the building and in the spaces between the three basement wings. They included concrete walls, sumps, chambers, footings and foundations. The age and function of these structures are not known, but they are apparently not related to previous DAC or McDonnell Douglas operations.

1.1.2.2 Building 2

Building 2 was an approximately 1,000,000 square foot structure that was used by DAC for aircraft assembly and as a parts storage warehouse. Aerial photographs suggest that early (1940s) activities in the building included aluminum production operations.

The building was divided into six east-west wings that were separated from each other by outdoor patio areas. The patio areas were not continuous across the length of the structure. There were four separate patio areas between each east-west wing. Uses of each patio varied. Three of the patio areas were improved with the construction of two-story office structures, while others were apparently recreation areas. Four mezzanine levels, used primarily for storage, existed at various locations throughout the building.

1.1.2.3 Building 3

Building 3 was a three-story, brick office building that housed DAC administrative offices and laboratories. This structure enclosed approximately 168,000 square feet. A review of historical documents indicates the presence of a relatively small paint laboratory, a chemical laboratory, an UST and two electrical transformers inside Building 3.

Prior to occupation by DAC, the building was used by the Aluminum Corporation of America as a rectifier building. Aerial photographs from the 1940s show a large number of electrical transformers on the west side of the building. DAC facility drawings show that the building was renovated into its final layout in 1952.

1.1.2.4 Building 19

Building 19 was an approximately 7,500 square foot brick building that housed the security office and emergency services for the Facility. The building also served this function during the period of aluminum manufacturing.

1.1.2.5 Building 20

Building 20 served as the vehicle maintenance area. Improvements of environmental interest included a battery recharging area, a 3-stage clarifier draining a steam cleaning booth, an above ground motor oil tank, hydraulic lifts and a condensation pit. Outside the building, there were USTs that dispensed unleaded and regular gasoline from a pump island.

1.1.2.6 Building 32

Building 32 was built in the 1980s and contained a cafeteria and meeting hall. A relatively small salvage yard was located outside the building to the north. A materials transfer area, paint storage, oil storage and USTs were located immediately north, west and southwest of Building 32, respectively.

1.1.2.7 Building 36

Building 36 was located directly north of Building 1. Building 36 was approximately 6,000 square feet in size and was used as a paint and solvent storage area. There were four USTs immediately south of Building 36 (15T through 18T) used for storage of solvents, alcohol and waste solvents.

1.1.2.8 Building 66

Building 66 was an approximately 200,000 square foot warehouse that was constructed in 1972. Prior to its construction, this area of the Facility was a storage yard. Other activities in the building included assembly of shipping supplies and light tooling operations.

1.2 PREVIOUS SOIL INVESTIGATIONS AND USTS

Over the past 15 years, DAC and Boeing have conducted a number of environmental investigations on Parcel C. In addition to the efforts summarized below, there have been numerous investigations carried out on the other three parcels that made up the Facility. Figure 3 shows the locations of the investigations described below.

1.2.1 Non-UST Previous Soil Investigations

Woodward-Clyde, 1988. In 1988, approximately 122 cubic yards of chromium-impacted soil were excavated from areas near the chromic acid tanks in Building 2. Due to building stability issues with further excavation, an unreported volume of soil with chromium concentrations up to 170 mg/kg was left in place. (Woodward-Clyde, 1988c). Woodward-Clyde concluded that the volume of soil left in place with elevated chromium was probably relatively small. They noted a rapid reduction in chromium concentrations laterally, with a concentration of 1.3 mg/kg just three feet from the sidewall sample containing 170 mg/kg chromium. Extrapolating this trend, Woodward-Clyde estimated that the elevated chromium impacts extended no more than a foot or two beyond the limits of the excavation. This area was reinvestigated during the current program as environmental feature (EF) A17 and no elevated chromium nor other impacts were found.

Environmental Solutions, 1989. In 1989, subsurface soil sampling in the vicinity of the former chrome plating tanks in Building 2 indicated that hexavalent chromium concentrations ranged from a low of 80 mg/kg at 7.5 feet bgs to a high of 1,400 mg/kg at 2.5 feet bgs. DAC personnel reported that soils were removed until total chromium concentrations in residual soil were below 50 mg/kg, and the excavation was backfilled (Environmental Solutions, 1989). This area was reinvestigated during the current program as EF 46A and no elevated chromium nor other impacts were found.

Kennedy/Jenks, 1996, 1997. In 1996, Kennedy/Jenks prepared a Phase I Environmental Site Assessment (ESA) of Parcel C (Kennedy/Jenks, 1996). Guided by the findings from the Phase I, Kennedy/Jenks conducted a relatively comprehensive soil investigation of the Facility in 1997 (Kennedy/Jenks, 1997a, 1997b, 1997c). This effort, referred to as the "2BB Study" included sampling from at least 212 soil borings. Soil samples were analyzed for Volatile Organic Compounds (VOCs) and Total Petroleum Hydrocarbons (TPH), and selected samples were analyzed for semi-volatile organic compounds (SVOCs), metals, polychlorinated biphenols (PCBs) and/or pesticides. The results of the 1997 study were combined with the more recent data and are included as part of the database used to prepare this report.

1.2.2 USTs

A total of 26 regulated USTs were reported to have historically been used in Parcel C. Former UST locations are shown on Figure 3. The locations in Figure 3 are based on a 1987 Woodward-Clyde map reproduced in Appendix D. All 26 documented tanks have been removed and regulation of the UST cases has been consolidated with the LARWQCB. Closure requests have been submitted for 22 tanks and are currently under review by the LARWQCB. The remaining four former USTs (15T through 18T) were in the location of an active remediation effort (Building 1/36 Area). A summary of the status of the USTs in Parcel C is provided in Table 1. This summary includes information from investigations described above as well as from activities conducted as part of this project. For most USTs, environmental issues were addressed in previous investigations during or shortly after the actual tank removals, as described below.

Woodward-Clyde, 1987, 1988. In 1987, Woodward-Clyde Consultants conducted a survey of USTs at the Facility. In 1988, Woodward-Clyde Consultants conducted a second phase of their UST assessment and completed a drilling program designed to evaluate whether releases had occurred from USTs and sumps at the Facility. Woodward-Clyde completed 17 soil borings and 10 vadose zone wells to depths of 30 to 40 feet. Soil samples were collected at 5-foot intervals and were analyzed for TPH and VOCs. For seven Parcel C UST locations (1T, 3T, 11T, 12T, 13T, 14T, and 20T; see Figure 3) no evidence of impact was detected. One additional UST (4T) had a detection of TPH at a concentration of 42 mg/kg, which is below Los Angeles Fire Department clean-up standards. These data, along with confirmation samples collected when the USTs were subsequently removed, were submitted to the LARWQCB for closure of these UST cases.

As part of Woodward-Clyde's UST program, remediation by excavation was conducted at UST 8T. This UST had been removed in 1987 and TRPH was detected in confirmation samples from the tank excavation with concentrations up to 3,286 mg/kg. Woodward-Clyde excavated approximately 180 cubic yards of impacted from the former location of UST 8T in 1988 (Woodward-Clyde, 1988a). Five confirmation samples were collected from the sidewalls and bottom of the excavation. Four confirmation samples had no detectable TPH and one contained 160 mg/kg of heavy TPH (in the C_{18} – C_{30} carbon chain range). Based on these results, Jeff Copeland of the LARWQCB verbally approved the adequacy of the remediation in January 1988, although a formal closure determination was apparently not granted at the time. This data has been forwarded to the LARWQCB for closure of the 8T UST case.

Crosby & Overton, 1987, 1988. In 1987, Crosby & Overton removed 12 USTs from the Facility, of which six were located in Parcel C (27T, 28T, 30T, 31T, 32T and 37T; see Figure 3). None of the confirmation soil samples from one of the Parcel C USTs contained detectable concentrations TPH. This data, confirming a lack of impact at UST 30T, has been submitted to the LARWQCB for closure of these cases. Soil samples from the five remaining UST excavations (27T, 28T, 31T, 32T and 37T) indicated the presence of TPH. In 1988, Crosby & Overton investigated these five UST locations by advancing one boring at each location (Crosby & Overton, 1988a). Twenty-three soil samples were collected and of these, 11 were analyzed for TPH and VOCs. Samples from the UST 27T location were found to have a maximum concentration of TPH of 310 mg/kg. The maximum detected concentration of TPH at former UST 28T location was 610 mg/kg at 10 feet bgs. A sample from 3 feet below the bottom of the former UST 31T excavation contained TPH at a concentration of 1,300 mg/kg. At the location of former UST 32T, the maximum detected concentration of TPH was 360 mg/kg at 10 feet bgs. At the former UST 37T location, TPH was detected in a soil sample from 10 feet bgs at a concentration of 140 mg/kg.

Based on the above results, Crosby & Overton overexcavated the tank pits for USTs 32T and 37T. Excavated soil volumes are not provided in the report (Crosby & Overton, 1988b), but the 32T excavation was extended to a depth of 14 feet and the 37T excavation was extended to a depth of 18 feet. The confirmation soil sample from the 32T excavation did not contain concentrations of TPH. Confirmation soil samples from the 37T excavation contained trace concentrations of TPH (<0.25 mg/kg). Based on these data, the 32T and 37T excavations were backfilled and a report (Crosby & Overton, 1988b) was submitted to Los Angeles County Fire Department for consideration of closure of these cases. Because oversight of UST cases has been consolidated with the LARWQCB, these data have been resubmitted to the LARWQCB for closure. Excavations for USTs 27T, 28T, and 31T were left open and were ultimately investigated by Tetra Tech in 1994 (see below).

Emcon, 1991. In 1991, three 5,000-gallon solvent USTs (16T, 17T and 18T) and one 3,000-gallon waste solvent UST (15T) were removed from the exterior breezeway between Buildings 1 and 36 (Figure 3) under the supervision of Emcon. Soil samples collected from beneath the tanks indicated that petroleum hydrocarbons and VOCs had impacted the surrounding soils. The impacted soils were left in place for future management by DAC (Emcon, 1992). During further assessment of the impacted area, soils were found to contain trichloroethene (TCE) and methyl ethyl ketone (MEK) to depths of 60 feet bgs. It was estimated that the lateral extent of impacted soils extended in a southeast direction beneath Building 1 (Montgomery Watson, 1994). This is the Building 1/36 area, addressed in detail during the current investigation. In particular, shallow impacted soil has been excavated and deeper soil is being remediated using SVE.

Maness Environmental, 1994. In 1994, Maness Environmental removed two 7,500-gallon (11T and 12T) and two 500-gallon hydraulic oil USTs (13T and 14T) from the east side of Building 1. Soil impacted with TPH was excavated and disposed of off-site (Maness, 1994). This area was reinvestigated by Kennedy/Jenks in 1997 (Kennedy/Jenks, 1997c) with samples collected to a maximum depth of 50 feet bgs from boring 2BB-1-38. Residual TPH was detected at concentrations less than 50 mg/kg, below local clean-up standards for TPH at the time. Maness Environmental also removed two 50,000-gallon diesel USTs (19T and 20T) north of Building 41 in 1994 (Maness, 1994). This work was all conducted under the oversight of the Los Angeles County Fire Department. Six soil samples were collected from the base of the 19T and 20T tank excavation. The maximum detected TRPH concentration was 52 mg/kg. Samples were also analyzed for TPH (diesel), aromatic hydrocarbons, and lead and none of these compounds were detected in the excavation samples. Based on these results, a closure request was submitted to the LARWQCB for all six tanks removed from Parcel C by Maness in 1994.

Tetra Tech, 1994. In 1994, Tetra Tech completed a soil assessment at the locations of three former USTs in Building 2 (27T, 28T and 31T; see Figure 3). The tanks had been removed by Crosby & Overton in 1987 and the excavations were left open. Twelve soil samples were collected from the bottoms of the excavations (four from 27T; five from 28T and three from 31T) and were analyzed for TPH and VOCs. Neither TPH nor VOCs were detected in any of the soil samples. During the current investigation, the locations of these former USTs were resampled as EFs U13 and U15 and no petroleum hydrocarbons were detected in soil. These data have been submitted to the LARWQCB for closure of these UST cases.

T&T Environmental, 1999. In 1998, Maness Environmental removed a 12,000-gallon gasoline tank east of Building 20 (Tank 1T). Three soil samples were collected from the bottom of the excavation. Soil samples were analyzed for TPH, VOCs, and lead. No TPH and no VOCs were detected in the soil confirmation samples. The maximum detected lead concentration was 5.1 mg/kg. Based on these results, T&T Environmental Services prepared a closure report for submittal to the Los Angeles City Fire Department (T&T Environmental Services, 1999). This information has been submitted to the LARWQCB for closure.

American Integrated Services, 2000. In 2000, American Integrated Services removed UST 88-01 east of Building 20. Two confirmation soil samples were collected from the bottom of the excavation and were analyzed for TPH, VOCs and lead. No TPH was detected in the confirmation samples. Total xylenes were detected in one sample at a concentration of 15 µg/kg; toluene was detected in one sample at a concentration of 8.7 µg/kg; and MTBE was detected in one sample at a concentration of 390 µg/kg. Based on these results, American Integrated Services recommended closure. The data from this investigation have been submitted to the LARWQCB for closure of this UST case.

Haley & Aldrich, 2001. In 2001, Haley & Aldrich conducted an investigation at the location of a former gasoline UST (29T). According to Boeing records, the capacity of the tank was between 300 and 550 gallons. Two soil borings were advanced to a depth of 30 feet and soil samples were collected at five-foot intervals. The 10-, 15- and 20-foot samples from each boring were analyzed for TPH. None of the six soil samples contained detectable concentrations of TPH. Based on these results, a closure request was submitted to the LARWQCB (Haley & Aldrich, 2002).

1.3 GEOLOGIC SETTING

1.3.1 Regional Geology

BRC's Former C-6 Facility is located on a broad plain at an elevation of approximately 50 feet above mean sea level (msl). The U.S. Geological Survey (USGS) defines this area as the Torrance Plain, a Pleistocene-age marine surface and a subdivision of the Coastal Plain of Los Angeles and Orange Counties. The ground surface is generally flat or gently sloping with an eastward gradient of approximately 20 feet per mile. Surface drainage is generally toward the Dominguez Channel, approximately one mile to the east. The Dominguez Channel, in turn, flows southeastward toward the Los Angeles and Long Beach Harbors in San Pedro Bay.

The surface sediments in this area are assigned to the Lakewood Formation (California Department of Water Resources (DWR), 1961), a unit defined to include essentially all of the upper Pleistocene sediments in the Los Angeles Coastal Plain area. The Lakewood Formation includes deposits of both marine and continental origin, representing stream transport and sedimentation along the Pleistocene marine plain. The Lakewood Formation typically includes the Semi-perched Aquifer, the Bellflower Aquitard and the Gage Aquifer. Based on correlations of stratigraphic data from adjacent areas, it appears that the Semi-perched Aquifer is absent at the Facility. The Bellflower Aquitard is described as a heterogeneous mixture of continental, marine and wind-blown sediments, mainly consisting of clays with sandy and gravely lenses (DWR, 1961). The base of the Bellflower Aquitard is at an elevation of approximately -100 feet msl, which is approximately 150 feet bgs at the Facility. The underlying Gage Aquifer is a water-bearing zone of fine to medium sand and gravel confined by the Bellflower Aquitard. It is reported to be approximately 60 feet thick and is described as being of secondary importance as a water source (DWR, 1961) because of low yields.

The Lakewood Formation is underlain by the Lower Pleistocene San Pedro Formation, which continues to approximately 1,000 feet bgs in this portion of the Torrance Plain. Major water-bearing zones within the San Pedro Formation are the Lynwood and Silverado Aquifers. The tops of these aquifers are reported to be approximately 300 and 500 feet bgs, respectively (DWR, 1961). The Silverado Aquifer is a source of drinking water in the Coastal Plain.

1.3.2 Local Geology

Parcel C is underlain by up to ten feet of artificial fill. The fill is heterogeneous in composition and varies in thickness across the Parcel. The relatively fine-grained Upper Bellflower Aquitard is the shallowest natural stratigraphic unit encountered at Parcel C. It is continuous across the area, but it thins to the northwest and southwest (Figure 4). The Upper Bellflower Aquitard consists of laminated to massive yellowish brown silt and clay with local sands. It extends from directly beneath the fill to approximately 25 feet bgs at Parcel C.

Overall, the Bellflower Aquitard extends to approximately 150 feet bgs. Subdivisions within the Middle and Lower Bellflower Aquitard are discussed in Section 1.4. The Gage Aquifer underlies the Bellflower Aquitard. It consists of sandy sediments and ranges in thickness from 40 to 78 feet.

1.4 HYDROGEOLOGIC SETTING

Numerous groundwater investigations have been performed on Parcel C. Presently, 43 groundwater monitoring wells provide hydrogeologic and groundwater quality data across the Facility, 26 of which are within Parcel C.

The uppermost groundwater at the Facility appears to be under water table conditions at depths of 60 to 70 feet bgs in relatively permeable sediments of the Bellflower Aquitard. The Bellflower Aquitard is part of the regional Lakewood Formation and is illustrated on Figure 4. Beneath the Facility, the Bellflower Aquitard can be divided into four primary units:

- Middle Bellflower B-Sand (B-Sand). This unit occurs from approximately 60 to 90 feet bgs. It consists predominantly of medium-grained sands and has a hydraulic conductivity of approximately 10^{-3} cm/second. All but one of the groundwater monitoring wells (WCC-030) at the Facility are completed within the B-Sand.

- Middle Bellflower Mud (MBFM). This unit is discontinuous across the area, consists of layered silts and very fine sands and occurs from approximately 90 to 100 feet bgs. The MBFM appears to be present across most of Parcel C.

- Middle Bellflower C-Sand (C-Sand). The C-Sand unit consists predominantly of medium-grained sands, has a hydraulic conductivity between 10^{-3} to 10^{-4} cm/second and occurs from approximately 100 to 120 feet bgs.

- Lower Bellflower Aquitard (LBF). This unit consists of fine-grained silts, is reportedly continuous across the area, occurs at a depth of 110 to 120 feet bgs, and ranges in thickness of 10 to 25 feet. The Gage Aquifer underlies the LBF.

Groundwater flow within the Bellflower aquitard is predominantly to the south-southeast under a horizontal hydraulic gradient of approximately 0.001 feet/foot and flows at a rate of approximately 10 to 20 feet per year (Kennedy/Jenks, 2000f). Vertical hydraulic gradients are minimal and appear to be downward. Studies at the Del Amo site to the east showed that vertical hydraulic gradients from the upper to the lower units ranged from 0.0027 to 0.187 feet/foot

(CH2M-Hill, 1998). Chemical transport in groundwater at the Facility appears to be predominantly lateral in nature with bulk groundwater flow.

1.5 NEIGHBORING ENVIRONMENTAL CONCERNS

The Facility is bordered by several properties with documented environmental impacts: the Del Amo Superfund site is located to the east; the Montrose Superfund site is to the south; and the Industrial Light Metals (ILM) site is located to the west of the Facility. There is evidence of some groundwater impacts having migrated onto Parcel C from off-site sources, in particular, benzene from the Del Amo site and chlorobenzene and chloroform from the Montrose site both appear to have encroached on the southeastern corner of Parcel C (Haley & Aldrich, 2001y; Kennedy/Jenks, 2000f). Established potentially responsible party (PRP) groups are addressing environmental issues at these sites under the oversight of either the U.S. Environmental Protection Agency (USEPA) or California Department of Toxic Substances Control (DTSC).

2.0 PROJECT APPROACH

The first phase of this project was to identify and delineate areas in which vadose zone soils have been impacted by organic and/or inorganic compounds used at the Facility. A further component of the first phase was to provide sufficient design parameters for deep soil remediation. The second phase was to evaluate whether the impacts posed a potential risk to human health or groundwater quality. The third phase was to remediate shallow soils to facilitate regulatory closure and to expedite redevelopment.

The soil investigation focused on the types of operations reported to have been conducted in different parts of the Facility. As previously noted, features that, due to the nature of the associated operations, may have impacted subsurface conditions were identified as EFs. Examples of EFs include USTs, sumps, chemical process areas and chemical handling areas (Figure 5). Kennedy/Jenks (1996) identified most of the EFs at the Facility during the Phase I ESA; however, additional EFs were identified by Ogden Environmental and Energy Services, Inc. during the planning stage of the soil investigation. Large interior or exterior areas with no known record of chemical usage and, hence, no identified EFs, were considered "open areas." Examples of open areas include parking lots, dry storage areas and roadways. Although they had no known record of chemical usage, BRC elected to investigate open areas to minimize the likelihood of impacted areas being encountered unexpectedly during redevelopment.

The EFs and open areas were investigated by analyzing soil samples collected at various depths from direct-push and hollow-stem auger drilling rigs and soil gas samples collected from soil gas probes. The soil gas samples were analyzed for VOCs, and the soil samples were analyzed for a suite of organic and inorganic parameters selected based on the nature of the nearby former manufacturing or support operations. As the results of the analyses were received from the analytical laboratories, they were evaluated and compared to soil gas screening concentrations (SGSCs) or soil field action levels (FALs), as appropriate. The derivation and use of these risk-based, compound-specific SGSCs and soil FALs, which were developed specifically for this soil investigation, are described in Sections 2.1.2 and 2.1.3. In brief, SGSCs and FALs were used as a tool for assisting in impact delineation: an impacted area was deemed to be sufficiently investigated if the area exceeding SGSCs or FALs could be delineated. Tests for physical soil parameters such as moisture/density relationships, total organic carbon (TOC) content and hydraulic conductivity were also performed at selected locations throughout the Facility to provide input data for the risk assessment and potential future remedial design.

Using the data from the soil investigation, SRA calculations were performed to evaluate potential human health risk associated with the organic and inorganic compounds identified in the vadose zone as well as vapor migration from groundwater impacts. The SRA calculations were based on conservative exposure scenarios to assure that further evaluation or remedial action would not be required. An assessment of potential groundwater impacts from the organic and inorganic compounds identified in shallow soils was also conducted (see Appendix C).

Remediation by excavation was conducted in two phases. During site investigation activities and demolition of the buildings, shallow soil with elevated photoionization detector (PID) levels or visual indications of impacts was excavated and stockpiled temporarily on-site, pending further characterization. Based on the results of the SRA calculations and the groundwater protection evaluation, additional excavations were conducted as necessary to remove soil with concentrations that exceeded risk levels or posed a potential threat to groundwater quality.

After site characterization and demolition activities were completed, remedial excavation activities conducted, remediation confirmation samples collected, and grading completed, the SRA was completed to assess whether soil remediation was sufficient and to assess potential exposures from existing conditions (see Appendix A).

2.1 APPROACH TO THE SOIL INVESTIGATION

2.1.1 Project Planning Documents

The site-wide planning documents provided overall guidance on the approach and procedures for the soil investigation. The principal planning document for the soil investigation at Parcel C is the SAP and its various addenda. The SAP outlines the scope of the investigation customized to the unique history and characteristics of Parcel C; it also summarizes the quality assurance/quality control (QA/QC) plan for the program. The following site-wide planning documents provide more detailed information regarding soil investigation procedures:

Sampling and Analysis Plan. The SAP and its addenda describe the overall investigative approach and provide a procedural rationale for determining the scope of the investigation, the analytical tests to be performed and a "step-out" contingency plan for expanding investigations based on field observations and analytical results. The original SAP (Kennedy/Jenks, 2000a) summarizes the investigative plan for Buildings 1, 3, 19, 20, 32 and 66. Addendum A of the SAP (Kennedy/Jenks, 2000b) expanded the program to include Building 2. Draft Technical Memorandum No. 1 (Ogden, 2000a) provides recommendations for additional sampling to: a) investigate suspected VOC source areas; b) provide data in support of remediation design calculations; and c) provide data for the risk assessment. Supplement No. 2 (Haley & Aldrich, 2001a) describes a sampling plan to further investigate impacts related to a former chromic acid tank in the northwest quadrant of Building 2. Supplement No. 3 (Haley & Aldrich, 2001b) was prepared to describe BRC's plan to collect additional soil gas samples at two EFs in Parcel C. Finally, Supplement No. 4 describes the derivation of SGSCs for soil gas.

FALs for Soil. SAP Addendum No. 5 (Haley & Aldrich, 2001d) describes how FALs for soil were derived. FALs were calculated for all compounds likely to be encountered at the Facility. These conservative values are based on risk to human health and were used to guide impact delineation activities.

Import Soil Screening Program Plan. This letter report documents the criteria for evaluating the suitability of potential import soils for use at Parcel C (Kennedy/Jenks, 2000d).

Site-wide Health and Safety Plans (HASP). The HASPs describe procedures and precautions to be employed by site workers to protect against potential exposure to chemical and physical hazards during the soil investigation (Kennedy/Jenks, 2000e; Haley & Aldrich, 2001e).

Site-wide Soil and Waste Management Plan (SWMP). The SWMP describes procedures for handling, categorizing, segregating and disposing or recycling waste materials generated during the soil investigation (Ogden, 2000b).

Site-wide Risk Assessment Work Plan (RAWP). The RAWP outlines the standardized approach for assessing potential human health risks from possible exposure to impacted soil and groundwater in the subsurface. It also provides the approach for evaluating whether remediation may be warranted (Ogden, 2000c; Haley & Aldrich, 2001f).

The original SAP and other planning documents for Parcel C were submitted to the LARWQCB for review and approval in mid-2000; subsequent addenda were also submitted to and approved by the LARWQCB. In addition, the Cal-EPA Office of Environmental Health Hazard Assessment (OEHHA) reviewed and provided an approval with comments on the RAWP.

2.1.2 FALS for Soil

FALs are screening tools developed to provide a consistent basis for delineating impacted areas during the site investigation. FALs were derived for all individual organic and inorganic compounds likely to be encountered at Parcel C (Table 2) to account for potential human exposure to soil and the potential for constituents to leach from soil into groundwater. In general, an impacted area was considered adequately characterized if the lateral and vertical extent of soil impact exceeding the FAL could be delineated based on data from nearby soil samples and/or by extrapolating decreasing concentration trends.

FALs for individual chemicals are based on a combination of preliminary remediation goals (PRGs) promulgated by USEPA Region 9 (USEPA, 1999), soil screening levels (SSLs; USEPA, 1996) and background concentrations (for inorganic compounds; Haley & Aldrich, 2002) adjusted to reflect California EPA toxicity values. Because the redevelopment plan for Parcel C envisions commercial or light industrial facilities, the FALs were developed for this specific land use scenario. SSLs were derived by USEPA to establish acceptable soil concentrations that are protective of the quality of underlying groundwater.

For petroleum compounds, FALs were derived for individual compounds as well as hydrocarbon mixtures. The mixture FALs (e.g., gasoline, kerosene, diesel and fuel oil) were derived from calculations of residual saturation capacity for silty sand (considered to be a representative soil for the subject parcel). Below residual saturation capacity, any non-aqueous phase liquid remains bound in the soil matrix by capillary forces and is not subject to gravity flow. We note that FALs for *both* mixtures and individual constituents must be met before a decision for no further assessment can be made for petroleum mixtures.

2.1.3 Soil Gas Screening Concentrations

SGSCs are screening tools for VOCs developed to provide a consistent basis for delineating impacted areas based on soil gas data (Table 3). SGSCs serve the same purpose for soil vapor as FALs serve for soil. SGSCs were calculated for a commercial or light industrial land use scenario based on a reasonable maximum exposure (RME) model assuming upward migration of VOC vapor, accumulation in buildings and inhalation of indoor air. The San Diego Department of Environmental Health Site Assessment and Mitigation vapor migration model was used to estimate indoor air concentrations. The LARWQCB and OEHHA verbally approved the use of this model for this project. Chemical parameters needed for the modeling were obtained from online information sources including:

- USEPA Region 9 PRG data sheets.
- U.S. National Library of Medicine Hazardous Substance Data Bank.
- Risk Assessment Information System Toxicity & Chemical Specific Factors Data Base.

Geotechnical input parameters for soil, including dry bulk density, total porosity, air-filled porosity and TOC, were obtained from analysis of representative soil samples from the Facility.

Exposure parameters were obtained from the RAWP (Ogden, 2000c). It was assumed that impacts are present at a depth of ten feet below grade (this is the depth at which most soil vapor samples were collected) and extend beneath the entire footprint of a hypothetical single-story structure.

As analytical data became available during the investigation, it was reviewed and compared against the SGSCs to identify impacted areas and to determine whether an impacted area had been adequately delineated. In general, an impacted area was considered adequately characterized if the lateral and vertical extent of soil vapor impact exceeding the SGSC could be delineated based on data from adjacent borings and/or by extrapolating decreasing concentration trends.

2.1.4 Investigation Strategy for Environmental Features

The investigation focused on EFs identified from a review of historical aircraft and earlier manufacturing operations in Parcel C. Three main factors were considered in the selection of sampling locations for EFs: 1) past history of the Facility, including specific manufacturing processes, 2) historical soil and groundwater data (Kennedy/Jenks Consultants, 1997a,b,c, 2000c) and 3) inspection of the concrete slabs for indications of releases or specific reported processes. Examples of EFs include USTs, sumps, clarifiers, pipelines, degreasers, anodizing systems and hazardous chemical storage areas.

The SAP identifies the location of each EF, known operational uses and associated compounds of interest. The tables also present the sampling and analytical program for each EF, including the number of borings, sample depths and laboratory analyses for each EF and the open areas.

2.1.5 Investigation Strategy for Open Areas

"Open Areas" refer to portions of Parcel C that have not been identified as EFs, may or may not have a record of chemical usage and where no known investigation activities have been previously conducted. Examples of open areas include parking lots, roadways and interior workspaces not otherwise classified as EFs. Although no specific environmental concerns were initially identified in the open areas, BRC elected to investigate them to reduce environmental uncertainty and to minimize the potential for delays during redevelopment due to previously unidentified impacts.

Because open areas had no known environmental concerns, sampling within these areas was less intensive than the investigation of environmental features. To establish open area sampling locations, a 50-foot by 50-foot grid was placed over Parcel C and 10% of the grid nodes falling outside of EFs were randomly selected (Haley & Aldrich, 2001b). Soil samples collected from these borings were analyzed for VOCs, SVOCs, TPH, and inorganic compounds. Soil gas samples were also collected from open area sampling locations and analyzed for VOCs.

2.1.6 Step Out/Step Down Protocol

A contingency protocol was designed for expanding the scope of the sampling program at an EF or open area if the initial data indicated that the extent of an impact had not been fully delineated (e.g., the results of the initial samples were greater than the SGSCs or soil FALs, or the initial results did not show a decreasing concentration trend from the potential source or EF).

Specifically, borings could be advanced deeper than planned, or additional step-out borings could be drilled after evaluating the soil sample analytical results.

2.1.7 Environmental Database

Over the years, environmental data from Parcel C was compiled and recorded in several different formats and media. To provide a consistent and comprehensive repository of the data, England Geosystem, Inc. (England Geosystem), a subconsultant to Haley & Aldrich, updated and maintained an electronic database. Available paper and electronic records of soil, soil gas and groundwater data for the Facility were collected and indexed. Statistical subsets of the legacy[2] database were reviewed to assess its accuracy and completeness. In particular, England Geosystem/Haley & Aldrich collected all available chain-of-custody (COC) and laboratory reports for groundwater and soil samples collected at Parcel C. Five percent of the records (approximately 8,500 randomly selected records) were then hand-checked against the chains-of-custody and laboratory reports. The database was then updated with the corrected or omitted information. If more than five percent of the electronic data reviewed (0.25 percent of the original sample size) was found to contain errors, then another five percent of the legacy data was to be randomly extracted, reviewed and corrected until an estimated error rate of 0.25 percent was achieved for the entire database.

Having assessed the accuracy and completeness of the legacy data, England Geosystem/Haley & Aldrich then updated the database to include recently collected information. For new data (collected during this investigation), several verification and quality control tests were conducted including:

- Missing Data Analysis: to identify required data fields that do not contain data.
- Outlier Data Analysis: to identify data that exceed given data thresholds.
- Data Validation Analysis: to query data validation flags.
- Non-detect Assignment: to assign a value to non-detected chemical concentrations.
- Matrix Spike Analysis: to query matrix spike data for laboratory data packages and identify results that are outside of user-defined threshold limits.

[2] The term, "legacy data" refers to information collected by others during previous investigations.

A more detailed description of the database compilation and maintenance project is provided in Appendix E.

2.1.8 Data Quality

Data collection and evaluation during the soil investigation was performed in general accordance with the QA/QC protocol described in the SAP (Kennedy/Jenks, 2000a). The laboratories retained by BRC are certified by the State of California to perform the methods of analysis used during the soil investigation. In addition, a Field Data Manager from either Kennedy/Jenks or Haley & Aldrich reviewed field logs, field monitoring data and boring logs for quality and consistency.

Soil samples collected prior to the involvement of Haley & Aldrich in 2000 were classified as "historic" while the samples collected during and after 2000 were considered "recent." Haley & Aldrich maintained a running total of recent soil samples analyzed by Severn Trent Laboratory and grouped each sample by analysis method.

For data validation, Laboratory Data Consultants (LDC) validated approximately 11% of STL's soil analyses. Specifically, a three-tiered validation program was implemented. Approximately 8.6 percent of the STL soil sample analyses conducted were subjected to Tier 1 validation, approximately 2.1 percent were subjected to Tier 2 validation, and approximately 0.5 percent were subjected to Tier 3 validation. Tier 1 validation involves checking for completeness, sample holding time violations, and the laboratory's QA/QC procedures, including method blank, matrix spike, and matrix spike duplicate analyses. Tier 2 validation includes the Tier 1 elements plus checks for transcription errors and a review of instrument calibration data. Tier 3 validation includes the Tier1 and 2 elements plus qualitative and quantitative checks on the reported results using the raw data provided by the analytical laboratory. A summary of the data validation results and reports are included in Appendix F.

2.2 APPROACH TO INVESTIGATION CONFIRMATION MONITORING

Once the buildings and foundation slabs were removed, visual monitoring was performed and PID measurements were obtained to identify soil impacts not previously encountered and to better delineate impacts already identified during the investigation phase.

Kennedy/Jenks performed investigation confirmation monitoring at Parcel C concurrently with demolition activities. The monitoring included observation, field screening and sampling of soil as it was exposed by removal of the concrete slab and foundation elements at Parcel C.

To facilitate monitoring of soils exposed during building demolition, Kennedy/Jenks partitioned Parcel C into a lettered and numbered grid (A through AN, north to south; 1 through 24, east to west). Gridlines were established on approximate 50-foot centers and temporarily marked on the perimeter fence of Parcel C.

As the above and below ground structures were being removed by the demolition contractor, a Kennedy/Jenks field technician inspected exposed soils for staining and odors. A PID was used to screen samples from selected subgrids using the headspace method. A minimum of one soil sample from each major grid was screened with the PID. The PID screening results were recorded in field logs.

In locations where staining or odors were evident, where PID readings were above general background levels, or where there was knowledge of impacts from the pre-existing data, Kennedy/Jenks collected soil grab samples for laboratory analysis. The grab samples were generally collected at or just below the exposed ground surface. This sampling data was evaluated as part of the SRA and impacted areas were excavated as necessary.

2.3 APPROACH TO HUMAN HEALTH RISK ASSESSMENT

The SRA was conducted in accordance with the RAWP (Ogden, 2000), as revised based on the April 12, 2001 comments provided by OEHHA. Appendix A of this report includes more detailed information regarding the SRA performed for Parcel C. Appendix B contains the supporting SRA calculations. In general, the procedures referenced in the above-noted documents and followed herein conform to both USEPA and DTSC risk assessment guidance.

The objective of the SRA was to provide a conservative indication of risk to human health from potential exposure to site-related COPCs in soil and groundwater beneath Parcel C based on existing conditions (i.e., after completion of Parcel C investigation activities, demolition, remedial excavation, remediation confirmation sampling, and grading activities). The SRA was intentionally designed to be conservative so that no further risk assessment or remedial action will be required to protect human health if the SRA results indicate that the COPCs do not pose a significant risk to human health (i.e., the calculated risks are less than OEHHA-approved target acceptable risk levels). These OEHHA-approved risk levels are an excess lifetime cancer risk of 1×10^{-5} and a total hazard index for noncancer affects of 1.0.

2.4 APPROACH TO ASSESSMENT OF GROUNDWATER PROTECTION

The objective of the groundwater protection assessment is to evaluate whether existing impacts in shallow (<12 feet bgs) soils have the potential to degrade existing groundwater quality. A complete derivation of this assessment is provided in Appendix C of this report. Deeper soil is being addressed as part of the site-wide groundwater program. Even though shallow groundwater beneath and in proximity to Parcel C is not used as a domestic water supply, an assessment was performed of potential degradation to levels greater than California drinking water standards, specifically, maximum contaminant levels (MCLs). As described in Appendix C, the assessment was conducted assuming a conservative scenario regarding chemical migration and mixing in groundwater following approved USEPA and LARWQCB methodology and assumptions.

2.5 APPROACH TO SHALLOW SOIL REMEDIATION

2.5.1 Excavation of Shallow Soil

Remedial soil excavation was conducted in two phases at Parcel C. During site investigation and demolition of the buildings, shallow soil with elevated PID levels or visual indications of impact (e.g., discolored soils) was excavated and stockpiled temporarily on-site, pending proper disposal. Based on the results of the SRA calculations and the groundwater protection evaluation, additional excavations were conducted as necessary to remove soil with concentrations that exceeded OEHHA-approved risk levels or posed a potential threat to groundwater quality. If the chemical concentration contributed significantly to estimated risks greater than OEHHA-approved risk levels, the impacted soil was removed such that the reduced overall risk posed by any remaining concentrations was considered acceptable. Confirmation soil samples were collected from the base and/or sidewalls of the excavations to verify that the impacted soil had been adequately removed.

2.5.2 Investigation-Derived Waste and Stockpile Management

Stockpiles were managed in accordance with the SWMP (Ogden, 2000b). SRA calculations indicated that some soil from stockpiles could safely be replaced on the subject parcel; other stockpiles or portions of stockpiles required treatment and/or disposal. In addition, chemical concentrations for each stockpile or stockpile segment were evaluated to assess whether chemical concentrations in the stockpiles had the potential to degrade existing groundwater quality (see Appendix C). Table 4 provides a summary of the stockpiles and their disposition.

To evaluate human health risks, SRA calculations were conducted using maximum concentrations detected in each stockpile. These concentrations were separately compared to the maximum in-situ concentrations detected within the entire Parcel. Where the stockpile concentrations were greater than the maximum in-situ concentrations, they were used in the SRA calculations to assess whether replacing soil from the stockpile back on Parcel C resulted in risk above the OEHHA-approved risk levels.

To evaluate potential degradation to groundwater, an assessment was conducted assuming a conservative scenario regarding chemical migration and mixing in groundwater following approved USEPA and LARWQCB methodology and assumptions. This evaluation was conducted by comparing maximum chemical concentrations to site-specific SSLs derived from California drinking water MCLs. Details of the groundwater protection assessment are provided in Appendix C of this report.

In addition to the stockpiles, other investigation-derived waste (IDW) was handled in accordance with the SWMP (Ogden, 2000b). Concrete and asphalt cores were handled as non-hazardous construction debris. They were collected and transferred to roll-off bins for future recycling. Soil cuttings generated by drilling activities were collected and placed in 55-gallon drums or temporarily stockpiled. Because of the large quantities, the drums were assigned a unique identification number. A record of the contents of each drum was also maintained. The drums were disposed of at NuWay Live Oak Landfill or Chem Waste Management in Kettleman, California. Stockpiled soil not reused on-site was disposed of or recycled at Bradley Landfill in Los Angeles, California, TPS Technologies in Adelanto, California or ChemWaste Management in Kettleman, California. Manifests for waste disposal are included electronically on a compact disc in Appendix H.

2.5.3 Import Soil

BRC implemented an import soil screening program to address the suitability of potential import soil from an environmental standpoint. In general, the demolition and grading contractors were responsible for identifying potential sources of import soil. Each potential source of import soil was assigned a letter designation for tracking purposes, and basic information was collected such as the location, nature of the source and estimated volume of the potential import soil. Prior to sampling identified soils, Kennedy/Jenks and Haley & Aldrich reviewed readily available environmental reports and/or existing laboratory data provided by the BRC contractor.

Kennedy/Jenks and Haley & Aldrich then sampled soil from the potential import source in accordance with the Import Soil Screening Program Plan (Kennedy/Jenks, 2000d). In general, one sample was collected for each approximately 10,000 cubic yards of soil available from the potential source. Soil samples were analyzed by the BRC-contracted analytical laboratory for the following compounds:

- VOCs by USEPA Method 8260.
- TPH (total carbon chain) by USEPA Method 8015.
- Title 22 Metals by USEPA Methods 6010 and 7470/7471.
- Polynuclear aromatic hydrocarbons (PAHs) by USEPA Method 8310.

Analyses for SVOCs, pesticides and/or PCBs were added if background information about the potential source suggested that these compounds may be present in the soil.

Analytical results were provided via electronic data deliverables (EDDs). Upon receipt of the complete EDDs for a particular potential source of import soil, Haley & Aldrich's risk assessment personnel evaluated the data with respect to the soil screening criteria. Soil screening criteria were established and are tabulated in the Import Soil Screening Program letter report (Kennedy/Jenks, 2000). If the screening criteria were exceeded for one or more compounds, and/or the detected metals concentrations were considered to be above background concentrations, the soil was rejected for use as import soil for Parcel C.

For each potential source that passed the screening test, Haley & Aldrich completed a Technical Memorandum summarizing the results of the import soil evaluation and documenting the recommendation regarding suitability of the soil. Table 5 provides a summary of the sources of import soil that passed the screening tests and were used at the subject parcel. In accordance with the above procedure, any future sources of import soil that may be required to bring Parcel C to final grade will be evaluated and sampled as appropriate.

3.0 FIELD WORK AND ANALYTICAL PROGRAM

3.1 SOIL SAMPLING AND ANALYSIS

Parcel C has been extensively investigated for soil impacts: approximately 5,900 soil samples were collected from over 1,200 distinct locations (Figure 6) in accordance with the SAP and other planning documents cited in Section 2.1.1. Field activities were initiated with the selection of sampling locations, notification and clearance by Underground Services Alert, coring of slabs and paving (where necessary) to access subsurface soils, and land surveying.

Sampling was accomplished using either grab samples, direct-push or hollow-stem auger drilling methods. Grab samples were collected in glass sampling jars or stainless steel tubes by collecting material from a backhoe bucket using a hand trowel or by pushing the tube directly into in-place soils. Sampling jars had threaded, Teflon-lined lids. Stainless steel tubes were assembled with Teflon liners and plastic end caps. Samples identified for organic compound analysis were prepared such that no headspace was present in the jars or tubes. Jars and tubes were labeled, placed in coolers with blue ice and transported with chain-of-custody documentation to a state-certified laboratory. Sampling equipment that was re-used was decontaminated between sampling events as described in Section 3.5.2.

Soil samples from the direct-push rigs were obtained by using one of two primary methods: a 2.0-inch outer diameter, 36-inch long coring tube sampler or a 2.0-inch outer diameter, 24-inch long discrete piston sampler. The samplers were threaded onto the leading edge of a 1.5-inch diameter probe rod and advanced to depth using the direct-push system. The probe rods were nominally four feet in length, and additional rods were connected to reach the desired depth. Soil samples were retrieved by retracting the probe rod and sampler to the surface and disassembling the sampler. Soil samples were sealed in the acetate sampler liners or transferred to stainless steel tubes and prepared as described above.

Samples from hollow-stem auger drill rigs were collected using a California-modified split spoon sampler and stainless steel tubes. Sampling tubes were prepared, documented, and transported as described above.

The lithology encountered at each boring was logged by field geologists using the Unified Soil Classification System (USCS) methodology. Geologic logging was conducted under the supervision of a California Registered Geologist or Professional Civil Engineer. Boring logs for borings greater than 50 feet deep are compiled in Appendix G. The IDW was labeled, inventoried and stored at Parcel C for later disposal by BRC.

3.1.1 Chemical Soil Testing

Soil samples were analyzed for some combination of the parameters listed below, depending on the nature of the EF. Samples collected by Haley & Aldrich and Kennedy/Jenks were submitted to STL, Del Mar Analytical Laboratories, or Orange Coast Analytical, all California-certified facilities. The specific analytical suite for each EF is presented in Table 6. Laboratory analytical reports are available for review from BRC.

Parameters	USEPA Method No.
Volatile organic compounds (VOCs)	8260B
Total petroleum hydrocarbons (TPH)	8015(CC)
Semi-volatile organic compounds (SVOCs)	8270C
Polynuclear aromatic hydrocarbons (PAHs)	8310
Polychlorinated biphenyls (PCBs)	8082
Metals	6010B/6020/7000S
PH	9045

Please note that some analytes were analyzed by EPA Method 8270 and EPA Method 8310. Where variances were noted in data resulting from the application of these two methods, the more definitive EPA Method 8270 (using GC/MS) was used.

3.1.2 Geotechnical Soil Testing

Several geotechnical laboratory tests were performed on soil samples collected from borings I-34, D-29 and I-25 at depths of 5, 20 and 50 feet. The physical soil tests were performed in accordance with American Society for Testing and Materials (ASTM) and other standard methods, as follows:

Parameters	Method
Dry bulk density	ASTM D-2937
Moisture content	ASTM D-2937
Total organic carbon	Walkley-Black Method
Sieve analyses	ASTM D-422
Total porosity	ASTM D-854
Air-filled porosity	ASTM D-854

The tests were performed by PTS Laboratories, Inc., of Santa Fe Springs, California, under subcontract to STL. Laboratory analytical reports are available for review from BRC.

3.2 SOIL GAS SAMPLING AND ANALYSIS

A total of 169 soil gas samples were collected and analyzed at Parcel C (Figure 7). Environmental Support Technologies, Inc., a licensed soil gas subcontractor, performed the surveys using a truck-mounted direct-push drilling rig to advance the sampling points and a mobile laboratory to analyze the soil gas samples. Procedures were followed in accordance with the LARWQCB's *Work Plan Requirements for Active Soil Gas Investigation* and *QA/QC Reporting Requirements for Soil Gas Investigation.*

Soil gas samples were collected within EFs and in open areas to assess the presence of possible unknown VOC impacts. For EFs, the soil gas sampling locations were specified in the SAP, and supplemental locations were added to the program in Technical Memorandum No. 1 (Ogden, 2000a) and SAP Supplement No. 3 (Haley & Aldrich, 2001b). To determine soil gas sampling locations in open areas, a 50-foot by 50-foot grid was placed over Parcel C. Ten percent of the grid nodes were randomly selected in the open areas for soil gas sampling.

Most soil gas samples (145 samples) were collected from a depth of 10 to 12 feet, although 20-foot samples were collected from 24 locations suspected of having deeper impacts. All soil gas samples were analyzed for VOCs in the field by Environmental Support Technologies' mobile laboratory using the Well Investigation Protocol (WIP) developed by the LARWQCB.

3.3 INVESTIGATION CONFIRMATION PROGRAM

This program of soil observation, field screening and sampling was conducted between November 2000 and May 2001. This work was conducted concurrently with the demolition of structures at the Facility and was designed to confirm that the soil investigation had adequately characterized the extent of impacted soil. As the foundations and slabs were removed, field personnel had access to the soil and were able to make visual observations of stained soil and take PID measurements. As part of this program, surface soil samples were collected and analyzed for TPH, VOC, PAH and/or inorganic compounds, as described below.

Viking Demolition, Inc. removed above and below ground structures, and a Kennedy/Jenks field technician inspected exposed soils for staining and odors. A PID was used to screen samples from selected subgrids using the headspace method. A minimum of one soil sample from each major grid was screened with the PID. The PID screening results were recorded in field logs. In locations where staining or odors were evident or where PID readings were above general background levels, Kennedy/Jenks collected soil grab samples for laboratory analysis. The grab samples were generally collected at or just below the exposed ground surface.

3.4 SHALLOW SOIL REMEDIATION

Soil impacts were removed during or immediately after demolition of the buildings. Impacts were screened for risk and excavated where appropriate. For each excavation, confirmation soil samples were collected from the excavations to verify that the impacted soil had been sufficiently addressed. SRA calculations were again performed for the confirmation sample data to assess the need for additional excavation. Excavated soil was stockpiled temporarily on-site. Based on the sample results stockpiled soil was either placed back on the property or disposed of off-site, as described in Section 2.5.2.

3.5 RELATED ACTIVITIES

3.5.1 Preparations for Sampling

As part of planning for this soil investigation, information on subsurface utilities was gathered from several different sources. The sources of information included the Phase I ESA, reports on previous investigations, facility drawings and field observations by Kennedy/Jenks and Haley & Aldrich personnel. To gain the benefit of any undocumented, "institutional" knowledge, Boeing personnel also provided information on the location of subsurface structures and utilities.

All on-site utilities were shut off prior to this investigation; therefore, utility clearance activities such as geophysical surveys and hand auguring were not needed prior to drilling. Where necessary, Kennedy/Jenks cored the pavement or floor slab to gain access to the underlying soil.

3.5.2 Equipment Decontamination

Field equipment that routinely came into contact with soil was decontaminated in accordance with the field procedures outlined in QA/QC Plan. This procedure included washing the equipment with a non-phosphorous based detergent (or Liquinox), followed by successive rinses with tap water and deionized water.

3.5.3 Boring Abandonment

On completion of soil sampling activities, the borings were backfilled with bentonite grout by the tremmie method.

3.5.4 Surveying

The soil gas and soil boring coordinates and surface elevations for each boring are tabulated in the environmental database for this project. These points were located either by field measurements or were surveyed for location and elevation. The locations and elevations were surveyed relative to control points established by Tait Engineering, Inc. and/or other known reference points. The horizontal coordinates are based on an arbitrary coordinate system. Elevations are based on benchmark #21-00992 in the City of Los Angeles at an elevation of 54.718 feet.

3.5.5 Site Grading

As was previously noted, Facility structures in Parcel C have been demolished and the construction debris removed from the property. Parcel C has also undergone significant grading activities to accommodate construction activities related to redevelopment. During grading, a minimum of the upper 5 feet to a maximum of the upper 22 feet of soil was excavated and recompacted, and approximately 250,000 cubic yards of "clean" import soil was brought onto and distributed throughout Parcel C (Tait & Associates, 1998). The criteria for acceptance of import soil are described in Section 2.3.3. The current ground surface elevation is between 3 feet lower to 5.5 feet higher than the pre-grading ground surface elevation. The soil sample depths cited in this report refer to the pre-grading ground surface elevations. The average pre-grading site elevation was 51.5 feet msl.

4.0 SITE INVESTIGATION RESULTS

A summary of site investigation results for all EFs is provided in Table 6. A tabulation of soil gas and soil analytical results are provided in Tables 7 through 14. The original laboratory results are available for review from BRC. Shallow soil impacts (less than 12 feet) were identified at 34 locations in Parcel C. Constituents in shallow soil included arsenic, lead, petroleum hydrocarbons, TCE (and to a lesser extent, other VOCs) and PAHs (benzo(a)pyrene and dibenzo(a,h)anthracene). Deep soil impacts (greater than 12 feet) were identified in three primary areas. Constituents in deep soil include TCE, 1,1,1-TCA, minor amounts of other VOCs, and petroleum hydrocarbons.

4.1 VOCS AND PETROLEUM HYDROCARBONS

4.1.1 Soil Gas Results

Of the 169 soil gas samples collected from Parcel C, VOCs were detected in 57 soil gas samples. As shown in Table 7, ten individual VOCs were detected in soil gas, typically at very low levels. The highest detected concentrations of VOCs in soil gas are summarized in the following table, along with their corresponding SGSCs.

Constituent	Sample Number	Max. Detected Value (µg/L)	SGSC (µg/L)
1,1-DCA	22 12' DF-1	6	5,550
1,1-DCE	F28 20'	118	145
cis-1,2-DCE	D23 20' DF-2.5	8	34,800
1,1,1-TCA	D23 20' DF-2.5	24	958,000
TCE	52 12' DF-20	275	2,970
Tetrachloroethene (PCE)	S2 10'	25	1,550
Chloroform	J41 10'	3	1,230
Trichlorofluoromethane	11 10'	4	592,000
Toluene	S3-2 10'	7	255,000
Xylenes	S32 10'	7	736,000

The table above illustrates that no detected VOCs in soil gas exceeded their respective SGSCs. All other VOCs were detected at concentrations below 10 µg/L.

4.1.2 Shallow Soil Results

Based on the analytical data from the current and previous investigations and the iterative risk-screening process, shallow soil VOC and TPH impacts were detected at 24 locations across Parcel C. In general, the shallow soil impact consists of many small areas scattered across Parcel C related to past operations. Two of these areas are near-surface portions of occurrences that also have deep impacts (Building 1/36 Area and Building 2 Area). The shallow impacts are discussed here and the deeper impacts are discussed in Section 4.1.3. Details regarding concentrations and size of the other shallow occurrences (which were subsequently excavated) are provided in Section 5.

Building 1/36 Area. At shallow soil depths, the Building 1/36 VOC plume is characterized by an irregular shape and relatively low concentrations of VOCs (Figure 8). The shallow extent of the impact is approximately 650 feet long and 300 feet wide and extends north into Parcel A. TCE is the primary constituent observed in this area and the maximum TCE concentration detected in samples from this depth is 260 µg/kg in soil boring 2BB-36-8 at 4 and 10 feet bgs.

Building 2 Area. At shallow depths, the TCE impact in the Building 2 area consists of several apparently isolated occurrences; the largest is in the western portion of Building 2 and is approximately 500 feet long and 370 feet wide (Figure 8). The highest detected TCE concentration at this depth interval is 4,000 µg/kg in soil boring S24-3 at 10 feet bgs, in the northwest portion of the Building 2 area. This sample was also reported to contain cis-1,2-DCE, 1,1,1-TCA, ethylbenzene, toluene and total xylene at concentrations of 2,200, 360, 620, 370 and 880 µg/kg, respectively.

4.1.3 Deep Soil Results--Building 1/36 Area

VOC impacts in this area appear to have originated from a former solvent storage area just north of Building 1, near Building 36. TCE is the most abundant organic compound with concentrations in soil up to 97,000 µg/kg (Figures 9 through 12); other detected organic compounds include cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), 1,1,1-TCA (Figure 13) and toluene (Figure 14). Some of the detected organic compounds are likely daughter products of TCE and TCA, suggesting some degradation of TCE and 1,1,1-TCA. The TCE impacts extend from the surface to the water table at approximately 65 feet bgs. Vertically, the highest concentrations are found at approximately 25 feet bgs, then again in or near the capillary fringe at 50 to 60 feet bgs (Figure 11). This concentration distribution appears to be related to the heterogeneous soil stratigraphy at Parcel C, with higher concentrations remaining in the finer-grained units. Laterally, high concentrations of VOCs are limited to a relatively small area near the northeast corner of Building 1. A detailed description of the Building 1/36 deep soil impact area is provided below.

20 to 25 Feet bgs. Compared to the shallow soil profile, VOCs at this depth are interpreted to be less irregularly distributed although concentrations are higher, and more individual compounds were detected in soil. Impacts at 20 to 25 feet bgs is approximately 1,050 feet long and 450 feet wide (Figure 9). The maximum TCE concentration in samples from this depth is 97,000 µg/kg in soil boring 2BB-36-13 at 19.5 feet bgs. A number of other VOCs were detected in this soil sample at relatively high concentrations, as follows:

- cis-1,2-DCE: 1,600 µg/kg
- 1,1,1-TCA: 33,000 µg/kg
- 1,1-DCA: 6,300 µg/kg
- 1,1-DCE: 5,400 µg/kg
- benzene: 1,200 µg/kg
- ethylbenzene: 370,000 µg/kg
- toluene: 3,700,000 µg/kg
- o-xylene: 690,000 µg/kg; and
- m/p-xylenes: 2,300,000 µg/kg.

50 Feet bgs. At this depth, the TCE plume is approximately 750 feet long and 450 feet wide and extends slightly north and east of Building 1 onto Parcel A (Figure 10). The highest TCE concentration detected in samples from this depth is 550 µg/kg in soil boring 2BB-36-13 at 49.5 feet bgs. This soil sample also had concentrations of 1,1,1-TCA, 1,1-DCA, 1,1-DCE, toluene and m/p xylenes of 1,400, 140, 140, 5,900 and 180 µg/kg, respectively.

60 Feet bgs. At approximately 60 feet bgs, the area of impact is not only larger than at 50 feet bgs, but it also has higher concentrations of some VOCs. Because this impacted area is within the capillary fringe, a soil impacts figure has not been prepared. The impacted area is approximately 1,750 feet long and 800 feet wide and extends to the east and south of this area (partially onto Parcel A). The highest TCE concentration detected in samples from this depth is 1,200 µg/kg in soil boring 2BB-36-11. This soil sample also has concentrations of 1,1,1 TCA, 1,1 DCE, 2-butanone and toluene of 5,900, 550, 240,000 and 7,100 µg/kg, respectively.

4.1.4 Deep Soil Results--Building 2 Area

VOC contamination in the Building 2 Area is apparently related to metal finishing processes and releases from one or more clarifiers. Impacts in this area were more diffuse and may be the result of multiple releases throughout the western portion of the building. As with the Building 1/36 Area, TCE is the most abundant organic compound with concentrations up to 340,000 µg/kg at 60 feet bgs (Figure 12). Other detected organic compounds include TPH, cis-1,2-DCE, 1,1-DCE, 1,1-DCA, 1,1,1-TCA and toluene (Figures 13 and 14). Some of the detected organic compounds are likely daughter products of TCE and TCA, suggesting some active reductive dechlorination of chlorinated compounds in this area.

Impacts extend from the surface to the water table at approximately 65 feet bgs (Figures 9-12). As in the Building 1/36 area, the highest concentrations and greatest extent are at approximately 25 feet, then again in or near the capillary fringe. The similarity in TCE distribution between the two major areas of impact supports the hypothesis that heterogeneity in the soil profile is a factor in controlling the distribution of VOCs in the subsurface. In general, higher concentrations remain in the finer-grained units.

20 to 25 Feet bgs. At 20 to 25 feet bgs, the area of TCE impact is approximately 1,000 feet long and 800 feet wide and extends into the central portion of Building 2 (Figure 9). The distribution of TCE appears to be more continuous compared to shallower depths. The highest TCE concentration detected at this depth interval is 24,000 µg/kg in soil boring S24-3 at 25 feet bgs. This soil sample also had cis-1,2-DCE and 1,1,1-TCA concentrations of 260 (estimated) and 730 µg/kg, respectively.

50 Feet bgs. At 50 feet bgs, the shape of the TCE impacted area is similar to the distribution at 20 feet (Figure 10): expressed as a continuous body approximately 850 feet long and 1,000 feet wide. Concentrations are higher at this depth than those encountered at 30 and 40 feet bgs, with a maximum TCE concentration of 82,000 µg/kg in soil boring S24-5. This soil sample also had 1,1,1-TCA at an estimated concentration of 820 µg/kg.

60 Feet bgs. At 60 feet bgs, the concentration distribution is more consistent across the impacted area, suggesting further coalescence of previously distinct releases. The TCE impacted area is approximately 1,300 feet long and 600 feet wide at this depth. Because these impacts are within the capillary fringe, a figure depicting these impacts has not been prepared. The highest TCE concentration in this plume is 340,000 µg/kg in soil boring S24-6. No other VOCs were reported in this soil sample.

4.1.5 Deep Soil Results Knox Street Right-of-Way

Impacts at the Knox Street Right-of-Way included TPH and TCE to a depth of approximately 26 feet bgs. Impacts from the Knox Street Right-of-Way were thought to originate from leaks from a heating oil pipeline that extended approximately 600 feet east-west across Parcel C. A comprehensive investigation delineated the release area and found that the impacted area extended laterally approximately 370 feet. The width of the impact varied along its linear extent, ranging from 20 to 50 feet. The depth of TPH impact also varied from a minimum of 7 feet to a maximum of approximately 26 feet bgs. Petroleum hydrocarbons (predominantly in the diesel and fuel oil ranges) in soil were measured at concentrations up to 23,000 mg/kg.

4.2 PAH and PCB COMPOUNDS

In deep soil, PAHs and PCBs were not detected at concentrations above their respective FALs. In shallow soil, however, seven occurrences were identified. Sample locations from the investigation are shown on Figure 6 and sample locations from the investigation confirmation sampling program are shown on Figure 15. The impacted soil was excavated from these areas as shown on Figure 16. Details regarding concentrations and size of these occurrences are provided in Section 5.

4.3 INORGANIC COMPOUNDS

Inorganic compounds were not detected in deep soil at concentrations above their respective FALs. In shallow soil, however, 13 occurrences were identified. The impacted soil was excavated from these areas as shown on Figure 16. Details regarding concentrations and size of these occurrences are provided in Section 5.

4.4 GEOTECHNICAL SOIL TESTS

Geotechnical tests were conducted to provide input data for both the SRA and for the design of interim remedial actions. Moisture content, bulk density, sieve analysis, porosity, and TOC were measured on samples from three depths (5, 20 and 50 feet bgs) at each of three locations. In general, the geotechnical tests showed the soil samples to consist of silts and fine sand, typical of the Bellflower Aquaclude. The tested soils were partially saturated and contained a low concentration of organic carbon (weight fractions of organic carbon varied between 0.0003 to 0.0024). The complete results of the tests are presented in Table 15.

4.5 CORRELATION BETWEEN SOIL AND GROUNDWATER IMPACTS

In summary, the location and distribution of groundwater quality impacts are consistent with the identified soil impacts (Haley & Aldrich, 2001y). In particular, there is a good spatial correlation between the location, distribution, and composition of groundwater impacts and areas of deep TCE impact in vadose zone soil (see Section 6 for a summary of groundwater conditions). Comparisons of the distribution of toluene and 1,1,1-TCA also show strong spatial correlations between soil and groundwater. The primary source areas contributing to VOC groundwater impact have been identified.

5.0 SHALLOW SOIL REMEDIATION

Guided by the results of the investigation confirmation program and SRA calculations, approximately 14,200 cubic yards of impacted soil were excavated from 34 locations on Parcel C (Figures 15 and 16). Table 16 provides an overview of the approximate size and location of each excavation as well as the constituents detected in the soil at each location.

Although most excavations were limited to shallow soils (<12 feet bgs), some excavations extended deeper if significant impacts were present and continued excavation was feasible. Most soil impacts were removed during or immediately after demolition of the buildings. Where there were visual indications of impact (e.g., odors or discolored soils), or knowledge of impacts from the pre-existing data, samples were collected. If impacts were detected, they were screened for potential risk to human health and potential threat to groundwater quality and, if necessary, scheduled for excavation. For each excavation, confirmation soil samples were collected to verify that the impacted soil had been sufficiently addressed. SRA calculations and a groundwater protection evaluation were again conducted for the confirmation sample data to assess the need for additional excavation. After completion of demolition and remedial excavation activities, the SRA was completed (Appendix A) using remaining in-situ sample data to assess potential risks from exposure to residual compounds in soil and groundwater.

5.1 VOCS AND PETROLEUM HYDROCARBONS

Excavations of VOC- and/or TPH-impacted soil are summarized below.

5.1.1 Knox Street Right-of-Way

As part of investigation confirmation monitoring in April 2001, an approximately 600-feet long section of heating oil pipeline was encountered beneath the proposed Knox Street Right-of-Way between Buildings 1 and 2. Upon removal of the subsurface piping, areas of soil staining and hydrocarbon odor were observed, and the extent of impact was identified by soil grab sample results along approximately 370 feet of the pipeline (see Figure 17).

On May 1 through 3, 2001, four trenches were excavated with a backhoe north to south, perpendicular to the impacted areas of the pipeline, in an effort to define the lateral and vertical extent of impacts. Kennedy/Jenks collected soil grab samples from the vertical and horizontal limits of the trenches. The results of the initial and trench grab sample analyses indicated an area of petroleum hydrocarbon impact 40 to 50 feet wide, 7 to 20 feet deep, extending approximately 370 feet along the south wall of Building 1. Impacted soils were defined to the north, south, east and west. A trench bottom sample (Build-1-M-16-050301-3 at 21 feet bgs) indicated petroleum hydrocarbon impacts deeper than 20 feet bgs. The initial pipeline excavation and exploratory trenches were backfilled temporarily for safety reasons.

In May 2001, petroleum hydrocarbon-impacted soils were excavated, under the supervision of Kennedy/Jenks, to the limits of the previous trench grab sample locations and where visual staining was evident. PID readings were also used to define the limits of petroleum hydrocarbon-impacted soil in the excavation. Additional confirmation grab samples were obtained by Kennedy/Jenks in the areas excavated deeper than 20 feet bgs.

Based on PID readings and the results of the confirmation grab sample analyses, an area of TPH- and VOC-impacted soil was encountered at approximately 15 to 26 feet bgs within Grid M-10 (Figures 17 and 18). During two separate operations in June 2001, these impacted soils were removed with an excavator under the supervision of Haley & Aldrich. Pre- and post-excavation TPH and VOC concentrations are shown in Figures 17 and 18. Sidewall and bottom confirmation grab samples were collected by Haley & Aldrich within the 12 by 31 foot excavation.

A total of approximately 5,000 cubic yards of soil were excavated in this area. The approximate dimensions of the final excavation were 50 by 370 feet and ranged from 5 feet to 26 feet in depth (Figures 17 and 18). Based on field screening readings and visual appearance, impacted excavated materials were segregated into temporary stockpiles that were evaluated and managed in accordance with Section 2.5.2. Non-impacted materials were placed adjacent to the excavations for eventual use as backfill.

Excavation sidewall and bottom confirmation samples had TPH concentrations ranging from non-detectable to 390 mg/kg (Build-2-M-10-052901-7 at 30 feet bgs) and TCE concentrations ranging from non-detectable to 42 μg/kg (Build-2-M-10-052501-6 at 26 feet bgs). Risk and fate and transport calculations demonstrated that the residual concentrations were within the acceptable range for protection of both human health and groundwater quality.

5.1.2 Building 1 (A-4)

Of the three soil samples collected in grid A-4, one (Build-1-A-4-120100-2) had concentrations of 260 mg/kg TPH, 32,000 μg/kg ethylbenzene, 740,000 μg/kg xylenes, and one (Build-1-A-4-112900-1) contained thallium at 2.3 mg/kg. Approximately 2 cubic yards of soil at this location was removed in an 3 foot by 4 foot area to a depth of approximately 5 feet bgs and re-sampled (Figures 15 and 16). Residual soil concentrations in the excavation (defined by confirmation sample Build-1-A-12-051801-1) were below OEHHA-approved risk levels.

5.1.3 Building 1 (D-3)

One soil sample collected in this stained area had a TPH concentration of 9,400 mg/kg and a TCE concentration of 36 μg/kg (Build-1-D-3-120400-1; see Figures 15 and 16). Approximately 5 cubic yards of soil were removed from this location to the limits of staining (an area with dimensions of approximately 5 feet by 5 feet) to a depth of approximately 5 feet bgs and re-sampled. The confirmation sample (Build-1-D-3-050401-2) had TPH and VOC concentrations below detection limits.

5.1.4 Building 2 (AF-17, "Heat Treat Pit")

Two soil samples (Build-2-AF-17-020901-1 and Build-2-AG-16-020901-1) collected from an area of hydrocarbon staining and odor adjacent to a heat treatment pit in Grids AF/AG-16/18, at approximately 1 foot bgs, had a copper concentration of 95.3 mg/kg and TPH concentrations up to 4,100 mg/kg. During removal of the concrete pit, impacted soils adjacent to the south wall of the pit were removed to a depth of approximately 18 feet bgs. Overall, the dimensions of this excavation were 65 feet by 35 feet and approximately 1,500 cubic yards of soil were removed (Figures 15 and 16). Residual soil concentrations in the excavation (defined by confirmation samples Build-2-AF-17-032901-3, Build-2-AF-17-032901-4, Build-2-AF-18-032901-1, Build-2-AG-17-032901-1 and Build-2-AF-16-040401-1) were below OEHHA-approved risk levels.

5.1.5 Building 2 (O-9)

One soil sample (Build-2-O-9-011001-1) collected in a stained area in Grid O-9, adjacent to a sump at approximately 3 feet bgs, had a TPH concentration of 12 mg/kg and low or non-detectable concentrations of metals, VOCs, SVOCs and PCBs. Approximately 5 cubic yards of stained soil were removed from this location in an area measuring approximately 5 feet by 5 feet and to a depth of 5 feet bgs and re-sampled (Figures 15 and 16). Residual soil concentrations in the excavation (defined by confirmation sample Build-2-O-9-050101-2) were below OEHHA-approved risk levels.

5.1.6 Building 2 (T-18)

One soil sample (Build-2-T-18-011501-1) collected in light green stained soils in Grid T-18 (Figures 15 and 16) at approximately 1 foot bgs had concentrations of chromium (1,560 mg/kg), copper (384 mg/kg), lead (104 mg/kg), molybdenum (38.5 mg/kg), cis-1,2 DCE (110,000 µg/kg), PCE (45,000 µg/kg) and TCE (490,000 µg/kg). Approximately 5 cubic yards of soil were removed at this location to the limits of staining (5 feet by 5 feet laterally and a depth of approximately 5.5 feet bgs) and re-sampled. Residual soil concentrations in the excavation (defined by confirmation sample Build-2-T-18-050101-2) were below OEHHA-approved risk levels.

5.1.7 Building 2 (T-20)

One soil sample (Build-2-T-20-010901-1) collected in oily, stained soils near a catch basin/clarifier in Grid T-20 at approximately 1 foot bgs had concentrations of chromium (158 mg/kg), lead (51.5 mg/kg), TPH (24,000 mg/kg), TCE (70 μg/kg), Aroclor 1260 (1,800 μg/kg), benzo(a)anthracene (7,100 μg/kg), benzo(a)pyrene (3,400 μg/kg) and dibenzo(a,h)anthracene (1,700 μg/kg; see Figures 16, 19 and 20). An exploratory trench was excavated to approximately 18 feet bgs at this location, and soils were re-sampled. The confirmation sample (Build-2-T-20-050101-2) had elevated levels of VOCs and SVOCs. Concentrations of chromium, lead and Aroclor 1260 were below OEHHA-approved risk levels. The excavation was backfilled with excavated material, and the area was designated for further investigation and remediation.

During July 2001, soil in this area was re-excavated during mass grading activities and placed in temporary stockpiles, which were managed in accordance with the protocol described in Section 2.5.2. The resulting excavation was approximately 55 feet by 57 feet in area, ranged in depth from 10 to 29 feet bgs and generated approximately 1,300 cubic yards of soil (Figures 19 and 20). Impacted soils removed from excavation T-20 had TPH concentrations up to 15,000 mg/kg (Build-2-T-20-071301-B21), 1,1,1-TCA concentrations up to 2,400 μg/kg (Build-2-T-20-071301-B24) and TCE concentrations up to 35,000 μg/kg (Build-2-T-20-071301-B24). TPH and VOC impacts remain at depths below approximately 29 feet bgs. Excavation sidewall confirmation samples had TPH concentrations ranging from non-detectable to 2,200 mg/kg (Build-2-T-20-071301-W17) and TCE concentrations ranging from non-detectable to 82 μg/kg (Build-2-T-20-071301-E19). SRA calculations showed that residual soil concentrations in the excavation meet acceptable risk thresholds for shallow soil. However, the remaining deep soil impacts may constitute a continuing threat to groundwater. The excavation was backfilled with non-impacted material, and the area has undergone pilot testing for remediation using SVE.

5.1.8 Building 2 (U-9)

One soil sample (Build-2-U-9-122700-1) collected in a stained area in Grid U-9 (Figures 15 and 16), adjacent to a sump, had a TPH concentration of 6,100 mg/kg (less than OEHHA-approved risk levels), and an Aroclor-1260 concentration of 9,200 μg/kg. The sump and approximately 5 cubic yards of stained soils at this location were removed. The dimensions of the excavation were 5 feet by 5 feet by approximately 5 feet deep. The confirmation sample (Build-2-U-9-050101-2) had Aroclor-1260 concentrations below detection limits.

5.1.9 Building 2 (W-11)

One soil sample (Build-2-W-11-050401-1; see Figure 16) collected in a stained soils adjacent to an oil pipeline in Grid W-11, at approximately 2 feet bgs, had concentrations of TPH (6,300 mg/kg; less than OEHHA-approved risk levels) as well as dibenzo(a,h)anthracene (720 μg/kg) and benzo(a)pyrene (790 μg/kg). Soils at this location were removed laterally to the limits of staining (approximately 35 feet by 10 feet) down to approximately 8 feet bgs and re-sampled. Approximately 130 cubic yards were removed from the W-11 excavation. The confirmation samples (Build-2-W-11-050901-2 and Build-2-W-11-050901-3) had TPH concentrations up to 390 mg/kg and a dibenzo(a,h)anthracene concentration of 260 μg/kg. Residual soil concentrations in the excavation (defined by the confirmation samples) were below OEHHA-approved risk levels.

5.1.10 Building 2 (X-11)

One soil sample (Build-2-X-11-010901-1) collected in a stained area in Grid X-11 (Figure 16), adjacent to a storm drain, had a TPH concentration of 850 mg/kg. The storm drain and stained soils at this location were removed to approximately 1.5 feet bgs and re-sampled. Approximately 7 cubic yards of soil were removed from an area measuring 10 feet by 12 feet. The confirmation sample (Build-2-X-11-043001-2) had a TPH concentration below detection limits.

5.1.11 Building 2 (Y-20)

One soil sample (Build-2-Y-20-040301-1; see Figure 16) collected in a stained area adjacent to an oil pipeline extending north-south along the western portion of Building 2, in Grid Y-20, at approximately 2 feet bgs had a TCE concentration of 92 μg/kg. Approximately 40 cubic yards of soil were removed from this location to the limits of staining (27 feet by 18 feet laterally and approximately 2 feet deep) and re-sampled. Residual soil concentrations in the excavation (defined by confirmation sample Build-2-Y-20-050101-2) were below OEHHA-approved risk levels.

5.1.12 Building 2 (Z-20)

Three soil samples collected in a stained area adjacent to an oil pipeline extending north-south along the western portion of Building 2, in Grid Z-20, down to approximately 5 feet bgs had concentrations of TCE up to 200 μg/kg (Figure 16). Approximately 10 cubic yards of soil were removed from this location from an area measuring approximately 5 feet by 5 feet and extending down 10 feet. Residual soil concentrations in the excavation (defined by confirmation samples Build-2-Z-20-052301-4 and Build-2-Z-20-052301-5) were below OEHHA-approved risk levels.

5.1.13 Building 2 (AA-20)

One soil sample (Build-2-AA-20-040301-1) collected in a stained area adjacent to an oil pipeline extending north-south along the western portion of Building 2, in Grid AA-20, at approximately 2.5 feet bgs had a TCE concentration of 46 μg/kg (Figure 15). Approximately 4 cubic yards of soil were removed from this location from an area measuring 5 feet by 5 feet and extending down approximately 4 feet. The confirmation sample (Build-2-AA-20-050401-2) had VOC concentrations below detection limits.

5.1.14 Building 2 (AB-20)

Two soil samples (Build-2-AB-20-020901-1, Build-2-AB-20-040301-2; see Figure 16) collected in a stained area adjacent to a storm drain in Grid AB-20, at approximately 1 and 2 feet bgs, had maximum TPH concentrations of 220 mg/kg. Approximately 5 cubic yards of soil were removed from this location from an area measuring 5 feet by 5 feet and extending down approximately 5 feet. Residual soil concentrations in the excavation (defined by confirmation sample Build-2-AB-20-051701-2) were below OEHHA-approved risk levels.

5.1.15 Building 2 (AD-14)

One soil sample (Build-2-AD-14-042601-1) collected in a stained area in Grid AD-14 (Figure 16) had a TPH concentration of 8,900 mg/kg and a benzo(a)pyrene concentration of 540 μg/kg. Approximately 50 cubic yards of soil were removed from this location from an area measuring 20 feet by 13 feet and to a depth of approximately 5 feet. The bottom and sidewall confirmation samples (Build-2-AD-14-042601-2 through Build-2-AD-14-042601-4) had TPH concentrations up to 510 mg/kg, and concentrations of metals, VOCs, SVOCs, PCBs and PAHs that were near or below laboratory detection limits. Residual soil concentrations in the excavation (defined by the confirmation samples listed above) were below OEHHA-approved risk levels.

5.1.16 Building 2 (AD-20)

One soil sample (Build-2-AD-20-040301-1; see Figure 16) collected in a stained area adjacent to an oil pipeline extending north-south along the western portion of Building 2, in Grid AD-20, at approximately 2.5 feet bgs had a TCE concentration of 190 μg/kg. Approximately 5 cubic yards of soil were removed from this location from an area measuring 5 feet by 5 feet and a depth of approximately 5 feet. The confirmation sample (Build-2-AD-20-050401-2) had VOC concentrations below detection limits.

5.1.17 Building 2 (AG-14)

One soil sample (Build-2-AG-14-020901-1; see Figure 16) collected in a stained area in Grid AG-14, above a former tunnel foundation, had a TPH concentration of 1,000 mg/kg. Concrete and stained soils at this location were removed to a depth of approximately 10 feet bgs across an area measuring 5 feet by 5 feet and re-sampled. The confirmation sample (Build-2-AG-14-052301-2) had a TPH concentration below detection limits.

5.1.18 Building 2 (AK-11)

This area was identified during the investigation confirmation monitoring process based on stained soil (Figurers 15 and 16). Approximately 46 cubic yards of impacted soil were removed from excavation AK-11 based on visual indications of staining and PID readings (Figure 21). The excavation was approximately 24 feet by 20 feet by 3 feet deep. Excavation bottom and sidewall confirmation samples had TPH concentrations ranging from non-detectable to 1,400 mg/kg (Build-2-AK-11-4, at 2 ft. bgs) and chloroform up to 8.1 μg/kg at 2 ft. bgs (Build-2-AK-11-1). Residual soil concentrations in the excavation (defined by confirmation samples Build-2-AK-11-11-1 through Build-2-AK-11-5) were below OEHHA-approved risk levels.

5.1.19 Building 2 (AK-13)

One soil sample (Build-2-AK-13-021901-1; see Figure 16) collected in a stained area in Grid AK-13, at approximately 3 feet bgs, had a TPH concentration of 700 mg/kg. Approximately 150 cubic yards of soil were removed from this location from an area measuring 20 feet by 50 feet and extending down approximately 3 feet. Residual soil concentrations in the excavation (defined by confirmation sample Build-2-AK-13-051401-2) were below OEHHA-approved risk levels.

5.1.20 Building 2 (AK-14/17)

This area was first identified during the site investigation with a detection of TPH (14,000 mg/kg), VOCs (benzo(a)pyrene [3,300 μg/kg]) and lead (28.5 mg/kg) in grab sample Build-2-AK-17-021501-1 at 1 foot bgs. The area was further delineated during the investigation confirmation monitoring process with soil samples Build-2-AK-17-032701-2 (9'), Build-2-AK-16-032701-3 (3'), Build-2-AK-17-032701-4 (4'), Build-2-AK-17-032701-5 (4') and Build-2-AK-17-032701-6 (3'). Soils at this location were removed to a depth of approximately 9 feet bgs (Figure 22) and stockpiled. Confirmation samples Build-2-AK-16-032701-3 (3'), Build-2-AK-17-032701-4 (4'), and Build-2-AK-17-032701-5 (4') were reported to have inorganic chemical concentrations within the range of site-specific background values and TPH and VOC concentrations below detection limits, with the exception of a TPH concentration of 630 mg/kg in the west sidewall (Build-2-AK-17-032701-4 [4']). The excavation was temporarily backfilled with non-impacted material to accommodate ongoing demolition activities.

Kennedy/Jenks then conducted step-out/step-down borings (F20-1 through F20-5) to further delineate the impacted area (Figure 22). TPH was reported below detection limits in soil samples collected between 10 and 30 feet bgs in F20-2, F20-3 and F20-4; between 10 and 40 feet bgs in F20-1; and between 10 and 60 feet bgs in F20-5, indicating that the initial impacts were removed.

During post-demolition grading, a second stain area was discovered and the impacted soils were excavated. The second excavation was approximately 18 feet by 30 feet by 13 feet deep. A total of approximately 265 cubic yards of soil were removed from this area and segregated based on PID readings. Approximately 50 cubic yards of impacted material was stockpiled from this excavation. Sidewall and bottom excavation samples had TPH ranging from non-detectable to 1,100 mg/kg (AK-14-5 at 13 feet bgs). Residual soil concentrations in the excavation (defined by the confirmation samples AK-14-1 through AK-14-5) were below OEHHA-approved risk levels.

5.1.21 Building 3 (R-23)

One soil sample (Build-3-R-23-040901-1; see Figure 16) collected in a stained area adjacent to an oil pipeline in Grid R-23, at approximately 2 feet bgs, had a TPH concentration of 290 mg/kg. Approximately 5 cubic yards of stained soil were removed from this location from an area measuring 5 feet by 5 feet and to a depth of approximately 5 feet. The confirmation sample (Build-3-R-23-040901-2) had a TPH concentration below detection limits.

5.1.22 Building 20 (M/L-23)

Five soil samples (Build-20-M-23-032101-1, Build-20-L-23-032101-2, Build-20-M-23-032101-4, Build-20-M-23-032201-7 and Build-20-L-23-051101-9) collected in a stained soils adjacent to an oil pipeline in Grid M/L-23 (Figure 16), to a maximum depth of approximately 7 feet bgs, had concentrations of TPH (up to 5,600 mg/kg), arsenic (up to 11.3 mg/kg), benzo(a)anthracene (14,000 μg/kg), benzo(a)pyrene (4,300 μg/kg) and 2-methylnaphthalene (54,000 μg/kg). Sidewall confirmation samples (Build-20-M-23-032101-3, Build-20-M-23-032101-5 and Build-20-L-23-032101-6) had inorganic compound concentrations of inorganic compounds within normal background range and TPH concentrations below detection limits. Approximately 200 cubic yards of soil were removed from this location from an area measuring 70 feet by 20 feet and a depth of approximately four feet. The confirmation samples, obtained in potholed areas in the base of the excavation up to 10 feet bgs, had TPH concentrations of up to 200 mg/kg. Residual soil concentrations in the excavation (defined by confirmation samples Build-20-M-23-050301-8 and Build-20-L-23-052301-10) were below OEHHA-approved risk levels.

5.1.23 Building 32 (32-4)

An occurrence of TCE was detected south of the Building 1/36 area near Building 32 (Figures 16 and 23). This area was first identified during the site investigation with the detection of TCE in soil boring C-32-4 (2,100 µg/kg at 1-foot bgs). This sample had 1,1,1-TCA, 1,1-DCA and toluene concentrations of 300, 96 and 79 µg/kg, respectively. The area was further delineated during the investigation confirmation process. This appears to be an isolated occurrence that is unrelated to the larger area of soil impacts in proximity to Building 1/36. VOCs were not detected at 5 feet bgs in the same soil boring. In late August 2000, an excavation in this area resulted in the removal of approximately 50 cubic yards of soil. The excavation was approximately 11 feet by 33 feet by 4.5 feet bgs. Residual soil concentrations in the excavation (defined by the confirmation samples Build-32-4-E-1 at 5 feet bgs and Build-32-4-E-2 at 4 feet bgs) were below OEHHA-approved risk levels.

5.2 PAH and PCB COMPOUNDS

PAHs were detected at five locations and PCBs were detected at two locations on Parcel C at concentrations above OEHHA-approved risk levels. Six of the PAH/PCB locations are described in Section 5.1 because they also contained petroleum hydrocarbons and/or VOCs. The remaining PAH/PCB location is described below.

5.2.1 Building 1 (C-13)

This area was identified and delineated during the investigation confirmation process (Figures 16 and 24) where it became evident that PAHs were the principal constituents of concern.

Between June and August 2001, approximately 40 cubic yards of soil in this area were removed with a backhoe under the supervision of Kennedy/Jenks and/or Haley & Aldrich to a depth of approximately six feet bgs. The area of the excavation was approximately 28 feet by 11 feet. Confirmation soil grab samples were collected at the limits of the initial excavation. Based on the laboratory analytical results of the initial confirmation samples, the initial excavation was expanded. As the excavation was expanded, additional confirmation samples were obtained by Haley & Aldrich. Residual soil concentrations of PAHs in the final excavation (defined by the confirmation samples Build-1-C-13-080101-4 through Build-1-C-13-080101-7, Build-1-C-13-080101-9 and Build-1-C-13-082401-15) were below OEHHA-approved risk levels.

5.3 Inorganic Compounds

Inorganic compounds were detected above background levels at 11 locations. Four of the inorganic locations are described in Section 5.1 because they also contained petroleum hydrocarbons and/or VOCs. The remaining locations are described below.

5.3.1 Building 1 (1-21)

This area was first identified during the site investigation with a detection of arsenic in soil borings 2BB-1-20, 2BB-1-19, 2BB-5-21, C-1-22 and others (Figures 25a and 25b). The area was further delineated during the investigation confirmation monitoring process. This excavation began as six separate locations clustered in an area immediately east of Building 1 that were eventually expanded into a single excavation. Between June and August 2001, soils in these areas were removed with a backhoe under the supervision of Kennedy/Jenks and/or Haley & Aldrich to depths (up to 7 feet bgs in localized areas) where previous analytical results indicated concentrations would be above OEHHA-approved risk levels. Confirmation soil grab samples were collected by Kennedy/Jenks and/or Haley & Aldrich at the limits of the initial excavations. Because confirmation samples were found to contain elevated levels of arsenic, direct-push borings were advanced around the perimeter of selected portions of the excavations and sampled (PD-41 through PD-82, PD-107 through PD-134, PD-142B through PD-163, and PD-169 through PD-207).

Arsenic-impacted soils removed from this area had concentrations up to 3,240 mg/kg (PD-70 at 1 foot bgs). Excavation sidewall and bottom confirmation samples had arsenic concentrations ranging from 2.6 mg/kg (Build-1-H-8-060101-5) to 8.4 mg/kg (Build-1-E-8-062601-17). Additional excavations were conducted in this area in September 2001. Approximately 4,900 cubic yards of soil were excavated from an area with dimensions of approximately 380 feet by 107 feet by 4 feet deep (on average). Excavated soil was stockpiled on-site pending analysis, and was then shipped for off-site disposal in October 2001. After completion of the September excavation, confirmation samples (PD-221 through PD-227) showed that the remaining arsenic in soil ranged from 2.9 mg/kg to 5.3 mg/kg, below OEHHA-approved risk levels.

5.3.2 Building 1 (J-4)

Grab samples were collected from stained soil in this area (Build-1-J-4-121500-1, -2, and -3; see Figure 16). Copper was detected at a concentration of 57.6 mg/kg and thallium was detected at an estimated concentration of 0.85 mg/kg. The stained soil was excavated from an area up to 6 feet deep that extended laterally 10 feet by 8 feet. Because the original grab samples subsequently proved to be below OEHHA-approved risk levels, confirmation samples were not necessary at this location.

5.3.3 Building 1 (B-15)

Grading operations in the northern portion of Parcel C revealed a structure resembling the bottom of a smokestack or chimney (Figures 16 and 26). The structure was discovered at approximately 8 feet bgs. The structure was circular, approximately 8 feet in diameter, and lined with bricks. It was filled with a black ashy material, which was sampled (BUILD-1-B-15-092701-10') and analyzed for VOCs, SVOCs, TPH, PAH, PCBs, and inorganics. Results indicated elevated concentrations of arsenic (27.2 mg/kg) and lead (29.6 mg/kg).

The structure was excavated and stockpiled on-site. Approximately 18 cubic yards of material were removed from the area. The structure extended to a depth of approximately 14 feet. An additional two feet of soil was excavated beneath the structure to ensure that all of the material was removed. A confirmation sample was collected from the base of the excavation (BUILD-1-B-15-092801-16'). Results indicated elevated concentrations of lead (97.1 mg/kg) and benzo(a)pyrene (2,200 μg/kg).

The area was revisited and an additional 100 cubic yards of soil was removed from an area measuring 16 feet by 16 feet and 12 feet deep based on visual observations and PID readings. The soil was stockpiled on-site. Three confirmation samples were collected at a depth of 12 feet (BUILD-1-B-15-100501-3, BUILD-1-B-15-100501-4, and BUILD-1-B-15-100501-5). The samples were analyzed for arsenic, lead, VOCs, and PAHs. All three confirmation samples were reported to be below laboratory detection limits for VOCs and less than OEHHA-approved risk levels for PAHs, arsenic and lead.

5.3.4 Building 2 (O-14)

Three soil samples (Build-2-O-14-042601-1; -2; and -4; see Figure 16) were collected beneath a chromium-stained clarifier structure in Grid O-14 at approximately 2 feet bgs. Concentrations of chromium (up to 597 mg/kg), hexavalent chromium (up to 569 mg/kg), arsenic (9.3 mg/kg) and lead (34.5 mg/kg) were detected at this location. Approximately 30 cubic yards of soil were removed from this location along with stained concrete from an area measuring 20 feet by 10 feet and extending down approximately 4 feet. Residual soil concentrations in the excavation (defined by confirmation samples Build-2-O-14-042601-3 and Build-2-O-14-052201-5) were below OEHHA-approved risk levels.

5.3.5 Building 2 (P-21)

This area was first identified during the site investigation with the detection of lead and TPH in boring C-2-242 at 5 feet bgs (Figure 16). The area was further delineated during the investigation confirmation process. Lead-impacted soils removed from excavation P-21 had concentrations up to 1,790 mg/kg and were apparently isolated at this location (Figure 27). The irregularly shaped excavation was approximately 18 feet long and approximately 10 feet bgs in depth. Approximately 40 cubic yards of soil were removed. The portion of soil representing boring 2-242 was segregated and stockpiled and the remainder of the soil was placed back in the excavation. Excavation sidewall and bottom confirmation samples had lead concentrations ranging from 4.6 mg/kg (P-21-060101-8, at 10 ft. bgs) to 8.4 mg/kg (P-21-060101-9, at 1 foot bgs). Residual soil concentrations in the excavation (defined by the confirmation samples listed above) were below OEHHA-approved risk levels.

5.3.6 Building 2 (V-14)

One soil sample (Build-2-V-14-042501-1) collected in blue/gray stained soils in Grid V-14 at approximately 1 foot bgs had concentrations of aluminum (74,700 mg/kg), copper (198 mg/kg), lead (65.7 mg/kg), TCE (75 μg/kg) and Aroclor 1260 (6,900 μg/kg) (Figure 16). Approximately 70 cubic yards of stained soil were removed from this location from an area measuring 10 feet by 20 feet and extending down approximately 4 feet. Residual soil concentrations in the excavation (defined by confirmation sample Build-2-V-14-042501-2) were non-detectable or below OEHHA-approved risk levels.

5.3.7 Building 2 (AN-19/23)

Three soil samples (Build-2-AN-19-051001-1, Build-2-AN-20-051001-1 and Build-2-AN-23-051001-1) collected in stained soils at approximately 1.5 feet bgs had arsenic concentrations up to 83.5 mg/kg (Figure 16). Approximately 270 cubic yards of soil were removed from a long, narrow area measuring 310 feet by 10 feet and extending down approximately 3 feet. Residual soil concentrations in the excavation (defined by confirmation samples Build-2-AN-18-052401-1, Build-2-AN-19-052401-2, Build-2-AN-20-052401-2, Build-2-AN-21-052401-1, Build-2-AO-22-051801-1 and Build-2-AN-23-051001-2) were below OEHHA-approved risk levels.

5.3.8 Building 3 (Q-23)

One soil sample (Build-3-Q-23-040901-2; see Figure 16) collected in a stained area adjacent to an oil pipeline in Grid Q-23, at approximately 2 feet bgs, had a lead concentration of 58.66 mg/kg. Approximately 5 cubic yards of soil were removed from this location from an area measuring 5 feet by 5 feet and extending down approximately 5 feet. Residual soil concentrations in the excavation (defined by confirmation sample Build-3-Q-23-051701-3) were below OEHHA-approved risk levels.

5.3.9 Building 32 (2BB-5-20)

This area was first identified during the site investigation with the detection of arsenic in boring 2BB-5-20 at one foot bgs (Figure 28). The area was further delineated during the investigation confirmation process with the use of direct-push borings advanced in selected areas around the excavation and sampled (PD-83 through PD-95). Arsenic-impacted soils removed from excavation Build-32-2-BB-5-20 had concentrations up to 170 mg/kg (based on boring sample 2-BB-5-20 at one foot bgs). Arsenic impacts generally occurred at a depth of approximately one foot bgs. Excavation sidewall and bottom confirmation samples had arsenic concentrations ranging from non-detectable (boring sample 2-BB-5-20 at 3 feet bgs) to 6.5 mg/kg (Build-32-2-BB-5-20-5). Samples from direct-push delineation borings had arsenic concentrations up to 18.8 mg/kg (PD-89 at 3 feet bgs). Approximately 50 cubic yards of soil were removed from two separate excavations in this area. The dimensions were approximately 20 feet by 15 feet for the first excavation and 8 feet by 8 feet for the second excavation. Both excavations reached a depth of approximately 4 feet bgs. Residual soil concentrations in the excavation (defined by arsenic levels measured in the confirmation samples listed above) were below OEHHA-approved risk levels.

5.3.10 Building 66 (66-9)

This area was first identified during the site investigation with a detection of arsenic in soil boring C-66-9 at 5 feet bgs (Figures 16 and 29). The area was further delineated during the investigation confirmation monitoring process. Excavation 66-9 was approximately 12 feet by 13 feet in area and 10 feet bgs in depth. Approximately 50 cubic yards of soil were removed during excavation. The arsenic-impacted soils removed from excavation 66-9 had concentrations up to 160 mg/kg. Arsenic impacts generally occurred at a depth of approximately 5 feet bgs. Excavation sidewall and bottom confirmation samples had arsenic concentrations ranging up to 6.3 (Build-66-66-9-6 at 10 feet bgs). Residual soil concentrations in the excavation (defined by the confirmation samples Build-66-66-9-2 through Build-66-66-9-6) were below OEHHA-approved risk levels.

6.0 SUMMARY OF PARCEL C BELLFLOWER AQUITARD GROUNDWATER CONDITIONS

The following section provides an overview of groundwater conditions beneath Parcel C based on the information presented in the Groundwater Monitoring Report-Annual Event, January/February 2001 (Haley & Aldrich, 2001y). Groundwater quality and depth underlying Parcel C are pertinent to the SRA presented in Appendix A and to the groundwater protection assessment presented in Appendix C. In a broader context, the groundwater quality data corroborates the findings of the soil investigation that indicate that potential sources of groundwater impact have been identified.

Groundwater monitoring at the Facility has been performed since 1987. Over this period, groundwater VOC concentrations have remained relatively constant or have declined. The latest groundwater monitoring event at the Facility was performed in January/February of 2001, and the results of this event are reported below.

Samples collected from select Bellflower aquitard monitoring locations in Parcel C were analyzed for VOCs using USEPA Method 8260B in accordance with the groundwater monitoring work plan (Kennedy/Jenks, 2000g). VOCs detected in groundwater samples collected from Bellflower aquitard monitoring locations in Parcel C are listed in Table 17. Selected groundwater samples collected at the Facility were also analyzed for inorganic compounds using USEPA Method 6010B. The analytical results are listed in Table 18. No inorganic compounds were detected in concentrations exceeding the USEPA MCLs in Parcel C.

TCE is the predominant VOC across Parcel C although several other VOCs have been detected. The most common VOCs are listed below along with the highest concentrations encountered in groundwater during the January/February 2001 sampling event:

- TCE (21,000 μg/L; see Figure 30)
- 1,1-DCE (24,000 μg/L; see Figure 31)
- 1,1,1-TCA (1,100 μg/L; see Figure 32)
- 2-butanone (18,000 μg/L)
- cis-1,2-DCE (4,600 μg/L)
- toluene (44,000 μg/L)
- chloroform (2,400 μg/L)

- 1,1-DCA (1,400 µg/L)

The VOC impacts in groundwater appear to originate from two areas of Parcel C: the former Building 1/36 chemical storage area around groundwater monitoring well TMW-2 and the former Building 2 clarifier and machining area in the vicinity of TMW-3 (Figure 30). VOC impacts in groundwater in these areas appear to substantiate the overlying deep soil VOC impacts.

Groundwater underlying Parcel C is also impacted from off-site sources along the southern and southeastern Facility boundary by benzene, chlorobenzene and methylene chloride from the Del Amo and Montrose properties. BRC is addressing groundwater quality issues at the Former C-6 Facility under a separate program.

7.0 SUMMARY AND CONCLUSIONS

7.1 SITE INVESTIGATION RESULTS

Parcel C of Facility has been extensively investigated for subsurface impacts: approximately 5,900 soil samples were collected at Parcel C from over 1,200 distinct locations. Soil samples were collected from the surface to depths of 65 feet bgs, which is the approximate depth of the water table. A total of 169 soil gas samples were also collected at Parcel C and analyzed for VOCs.

Shallow Soil Results. Impacted shallow soil (less than 12 feet bgs) was identified at 34 locations in Parcel C. Constituents in shallow soil included arsenic, lead, TPH, TCE (and to a lesser extent, other VOCs) and PAHs. Impacted shallow soil was excavated to remove constituent concentrations that exceeded risk levels in the SRA calculations or posed a possible threat to groundwater quality. Approximately 14,200 yards of soil were removed through this remediation effort.

Deep Soil Results. Although all shallow soil (<12 feet bgs) has been remediated, there were three areas where deep soil (greater than 12 feet bgs) was found to be impacted. At one area (the Knox Street Right-of-Way), both shallow and deep soil has been excavated to remove impacted areas above OEHHA-approved risk levels. The remaining impacts in deep soil in the Building 1/36 and Building 2 areas are to be remediated using SVE.

The Knox Street Right-of-Way included petroleum hydrocarbons and TCE to a depth of approximately 26 feet. TPH impacts from the Knox Street Right-of-Way are apparently the result of leaks from a heating oil pipeline that extended across Parcel C. The impacted area extended laterally approximately 370 feet. The width of the impact varied along the linear extent of the impacted area ranging from 20 to 50 feet. The depth of TPH impact also varied from a minimum of seven feet to a maximum of approximately 26 feet bgs. TCE impacts were also present in the eastern-most portion of this excavation. The TCE impacts may have been associated with machining in the northern portion of Building 2. Petroleum hydrocarbons in soil were measured at concentrations up to 23,000 mg/kg. TCE was detected in soil samples at concentrations up to 2,900 μg/kg. This area was remediated by excavation.

Soil impacts in the Building 1/36 area appear to have originated from a former solvent storage area north of Building 1 and south of Building 36. TCE is the most widespread organic compound with concentrations in soil up to 97,000 μg/kg; other detected organic compounds include cis-1,2-DCE, 1,1-DCE, 1,1-DCA, 1,1,1-TCA and toluene. The TCE impacts extend from 12 feet bgs to the water table at approximately 65 feet bgs. Any TCE residuals remaining in shallow soil have concentrations below OEHHA-approved risk levels. Laterally, elevated concentrations of VOCs are limited to a relatively small area near the northeast corner of Building 1.

VOC impact in the Building 2 area is apparently related to metal finishing processes and releases from one or more clarifiers. As with the Building 1/36 area, TCE is the most abundant organic compound with concentrations up to 340,000 μg/kg. Other detected organic compounds include petroleum hydrocarbons, cis-1,2-DCE, 1,1-DCE, 1,1-DCA, 1,1,1-TCA and toluene. Impacts extend from 12 feet bgs to the water table at approximately 65 feet bgs. Any TCE residuals remaining in shallow soil have concentrations below OEHHA-approved risk levels.

7.2 SCREENING-LEVEL HUMAN HEALTH RISK ASSESSMENT

Haley & Aldrich used a SRA approach during the investigation activities and after completion of site investigation, demolition, remedial excavation, remediation confirmation sampling, and grading. The objective of the SRA was to provide a conservative indication of risk to human health from potential exposure to site-related COPCs in soil and groundwater beneath Parcel C. The SRA was conducted in accordance with the OEHHA-approved RAWP and its addenda (Ogden, 2000 and Haley & Aldrich, 2001).

During the investigation activities, SRA calculations were used to evaluate soil and groundwater data obtained as the investigation was proceeding to ensure that there would be no significant human health risks associated with potential exposures to site-related chemicals. Based on SRA calculations conducted during the investigation activities, several areas of Parcel C were identified that would result in risks greater than the OEHHA-approved risk levels. The SRA calculations were used to assess the extent of soil remediation that would be necessary to lower the associated risks to less than the risk levels. After excavation activities, SRA calculations were conducted using the confirmation samples to verify that no further excavation activities were necessary.

After site investigation, demolition and remedial excavation activities were completed, remediation confirmation samples were collected, and grading activities were completed, the SRA was performed to assess the risk associated with potential exposures from the remaining residual concentrations. The SRA was designed to be conservative so that no further risk assessment or remedial action would be required to protect human health (i.e., the calculated risks for existing conditions are less than OEHHA-approved risk levels). The completed SRA is presented in Appendix A and indicates that for a future commercial/industrial land use scenario, the estimated excess lifetime cancer risk is approximately 50% lower than the OEHHA-approved level, and the total hazard index for noncarcinogenic effects is almost 10% below the OEHHA-approved risk level. Concentrations of lead, evaluated using the DTSC LEADSPREAD model, are also below the OEHHA-approved level.

Haley & Aldrich also evaluated whether impacts in shallow (within the upper 12 feet bgs) soils had the potential to degrade groundwater quality. Deeper soil is being addressed as part of the site-wide groundwater program. The maximum chemical concentrations in soil were compared to site-specific SSLs derived from primary or secondary MCLs. Results of this evaluation, presented in Appendix C, indicate that groundwater impacts will not occur based on the residual concentrations present in shallow soil.

Thus, based on the completed SRA and groundwater impact evaluation for shallow soil, Parcel C can be redeveloped for unrestricted commercial and industrial use.

7.3 SHALLOW SOIL REMEDIATION

Based on the results of the soil investigation and the SRA calculations, shallow soil exceeding OEHHA-approved risk levels was excavated and transported off-site for disposal. Approximately 14,200 cubic yards of impacted shallow soil were excavated from 34 locations on Parcel C. Figure 16 and Table 16 provide an overview of the size and location of each excavation as well as the constituents encountered in the soil at each location.

For each excavation, stained or impacted soils were removed and confirmation soil samples were collected from the base and/or sidewalls of the excavations to verify that the impacted soil had been sufficiently addressed. SRA calculations were again performed for the confirmation sample data to assess the need for additional excavation. The SRA calculations also included a groundwater protection evaluation.

Following excavation confirmation, clean soil was imported to fill the excavations and complete grading. Import fill sources were evaluated for historical use and analyzed for TPH, VOCs, inorganic compounds and PAHs. Import fill was accepted only when the historical use was not industrial and the analytical results were lower than the import soil criteria and/or considered to be within natural background concentrations. A total of approximately 250,000 cubic yards of import fill was placed in Parcel C using this method.

7.4 CONCLUSIONS

Parcel C has undergone a comprehensive investigation by collecting and analyzing soil and soil gas samples from probes, borings and grab samples targeted at identified EFs and distributed throughout the surrounding open areas. A SRA was conducted and shallow soil remediation was completed. Shallow impacts have been delineated and remediated such that the upper 12 feet of soil at Parcel C is suitable for closure. Accordingly, no further risk assessment, additional investigations, or remedial actions are recommended in shallow soil and Parcel C can be redeveloped for commercial or industrial use. Key conclusions from this project are:

- Soil impacts within Parcel C have been delineated to evaluate the associated potential risks to human health and groundwater.

- Areas of shallow soil impact were present throughout Parcel C and consisted of areas of relatively limited extent and low concentrations. The most common constituents in these scattered, small areas were petroleum hydrocarbons and VOCs, although some impacted areas included inorganic compounds, PAHs, and PCBs.

- Deep soil impacts occur in two areas: the Building 1/36 area and the Building 2 area. Impacts in these areas consist of VOCs with TCE being the predominant constituent. Toluene, 1,1,1,-TCA and other VOCs are also found in these areas. Deep soil impacts found in the Knox Street Right-of-Way were remediated through excavation.

- There is a good correlation between groundwater impacts and areas of elevated VOC concentrations in vadose zone soil, indicating that the primary source areas contributing to VOC groundwater impact have been identified.

- Shallow soil impacts posing a risk above OEHHA-approved risk levels were remediated through excavation. Based on SRA calculations, approximately 14,200 cubic yards of soil were removed from 34 excavations.

- The SRA was performed after completion of site investigation, demolition, remedial excavation, remediation confirmation sampling, and grading to evaluate risks to human health and the environment posed by existing soil conditions at Parcel C. The results of the SRA indicate that no further remedial excavation activities are necessary to protect public health.

- Deep soil and groundwater VOC impacts (below 12 feet bgs) do not pose a human health risk through vapor migration based on the results of the SRA.

- Based on the SRA and the groundwater protection evaluation, shallow soil can be closed with no further investigation or remedial action.

- Deep soil VOC impacts in the Building 1/36 and Building 2 areas will be addressed through the implementation of SVE remediation systems. Pilot testing for SVE has been completed in each of these areas and full-scale systems are being constructed.

- Groundwater impacts and other isolated occurrences of deep soil impact will be managed as part of a site-wide groundwater remediation program, which is currently under development.

Based on the soil investigation, remediation, and SRA activities, performed, Parcel C shallow soils meet OEHHA-approved risk levels and can be closed for further investigation or remedial action. As a result, Parcel C can be redeveloped for commercial and/or industrial use.

8.0 LIMITATIONS

This report was prepared by Haley & Aldrich, Inc., under the professional direction and review of the registered professionals listed on the cover page. The work described herein was conducted in accordance with generally accepted professional engineering, health risk assessment and geologic practice. No other warranty exists, either expressed or implied.

In addition to data collected by and observations made by Haley & Aldrich personnel, this report incorporates site conditions observed and described by others as reported in records available to Haley & Aldrich as of the date of report preparation. Haley & Aldrich relied—in part—on such data collected by others in the development of interpretations about environmental conditions at the Facility. The accuracy, precision, or representative nature of data originally generated by others could not be independently verified by Haley & Aldrich and would be beyond the scope of this project.

Assembly and maintenance of the electronic database used for this project is subject to the limitations cited in Appendix E. In addition, the passage of time may result in changes in site conditions, technology, or economic conditions which could alter the findings and/or recommendations of the report.

9.0 REFERENCES

American Integrated Services, Inc., 2000, *UST Closure Report.*

California Department of Water Resources, *Hydrogeology and Groundwater Resources of the Los Angeles Basin*,1961.

Camp, Dresser & McKee, Inc., 1991a, *Phase I Environmental Assessment of the Douglas Aircraft Company C-6 Facility, Parking Lot and Tool Storage Yard, Los Angeles, California.* June 13, 1991.

Camp, Dresser & McKee, Inc., 1991b, *Phase II Environmental Assessment of the Douglas Aircraft Company C-6 Facility, Parking Lot and Tool Storage Yard, Los Angeles, California.* August 21, 1991.

CH2M Hill, *Hydrogeology of the Del Amo Site, Los Angeles, California*, May 18, 1998.
Crosby & Overton Environmental Management, Inc., 1988a, *Site Assessment Investigation for Underground Tank Removed at the Douglas Aircraft Company C6 Facility.* February 8, 1988.

Crosby & Overton Environmental Management, Inc., 1988b, *Excavation of Hydrocarbon Contaminated Soil, Soil Sampling and Analysis at the Douglas Aircraft Company C-6 Facility.* October 16, 1988.

Emcon, Inc., 1992, *Closure Report for USTs 9T, 10T, and 15T through 18T, Douglas Aircraft Company - Torrance Facility (C6).* Prepared for Douglas Aircraft Company. April 27, 1992.

Environmental Solutions, *Inc., Soil Investigation – Hard Chrome Plating Secondary Containment Pit.* December 21, 1989.

Haley & Aldrich, 2002, *Closure Report, UST 29T, Boeing Realty Corporation Former C-6 Facility—Parcel C, Los Angeles, California.* January 30, 2002.

Haley & Aldrich, 2001a, *Sampling and Analysis Plan Supplement No. 2: Former Chromic Acid Tank Location, Parcel C.* February 15, 2001.

Haley & Aldrich, 2001b, *Sampling and Analysis Plan Supplement No. 3: Additional Soil Gas Samples, Parcel C.* February 22, 2001.

Haley & Aldrich, 2001c, *Sampling and Analysis Plan Supplement No. 4: Soil Gas Screening Concentrations.* March 2, 2001.

Haley & Aldrich, 2001d, *Sampling and Analysis Plan Supplement No. 5: Field Action Levels for Soil.* March 2, 2001.

Haley & Aldrich, 2001e, *Site-wide Health and Safety Plan for the Boeing Realty Corporation Former C-6 Facility, Los Angeles, California.* June 8, 2001.

Haley & Aldrich, Inc., 2001f. *Technical Memorandum: Risk Assessment Work Plan Addendum No. 1 for the Boeing Realty Corporation Former C-6 Facility, Los Angeles, California.* July 11, 2001.

Haley & Aldrich, Inc., 2001g, *Technical Memorandum: Import Soil Evaluation Use of Parcel B Soil as Import to Parcel C.* February 15, 2001.

Haley & Aldrich, Inc., 2001h, *Technical Memorandum: Import Soil Evaluation Use of Soil Sources F and G as Import to Parcel C.* March 6, 2001.

Haley & Aldrich, Inc., 2001i, *Technical Memorandum: Import Soil Evaluation Use of Soil Sources F and G as Import to Parcel C.* March 6, 2001.

Haley & Aldrich, Inc., 2001j, *Technical Memorandum: Import Soil Evaluation Use of Soil Sources H and N as Import to Parcel C.* April 11, 2001.

Haley & Aldrich, Inc., 2001k, *Technical Memorandum: Import Soil Evaluation Use of Soil Sources I and J as Import to Parcel C.* March 30, 2001.

Haley & Aldrich, Inc., 2001l, *Technical Memorandum: Import Soil Evaluation Use of Soil Sources I and J as Import to Parcel C.* March 30, 2001.

Haley & Aldrich, Inc., 2001m, *Technical Memorandum: Import Soil Evaluation Use of Soil Source K2 as Import to Parcel C.* April 30, 2001.

Haley & Aldrich, Inc., 2001n, *Technical Memorandum: Import Soil Evaluation Use of Soil Sources H and N as Import to Parcel C.* April 11, 2001.

Haley & Aldrich, Inc., 2001o, *Technical Memorandum: Import Soil Evaluation Use of Soil Source P as Import to Parcel C.* June 15, 2001.

Haley & Aldrich, Inc., 2001p, *Technical Memorandum: Import Soil Evaluation Use of Soil Source V as Import to Parcel C.* August 3, 2001.

Haley & Aldrich, Inc., 2001q, *Technical Memorandum: Import Soil Evaluation Use of Soil Source W as Import to Parcel C.* August 3, 2001.

Haley & Aldrich, 2001r, *Technical Memorandum: Import Soil Evaluation Use of Soil Source Y as Import to Parcel C.* September 4, 2001.

Haley & Aldrich, 2001s, *Technical Memorandum: Import Soil Evaluation Use of Soil Source AA as Import to Parcel C.* December 2001.

Haley & Aldrich, 2001t, *Technical Memorandum: Stockpile Placement/Disposition Evaluation, Stockpiles SP-1 Through SP-11.* July 19, 2001.

Haley & Aldrich, 2001u, *Technical Memorandum: Stockpile Placement/Disposition Evaluation, Stockpiles SP-12 and SP-14.* August 1, 2001.

Haley & Aldrich, 2001v, *Technical Memorandum: Stockpile Placement/Disposition Evaluation, Stockpiles SP-13, SP-15, SP-16,* August 20, 2001.

Haley & Aldrich, 2001w *Technical Memorandum: Stockpile Placement/Disposition Evaluation,* October 17, 2001.

Haley & Aldrich, 2001x *Technical Memorandum: Stockpile Placement/Disposition Evaluation,* November 30, 2001.

Haley & Aldrich, 2001y, *Groundwater Monitoring Report, Annual Event, January/February 2001, Boeing Realty Corporation, Former C-6 Facility, Los Angeles, California,* June 20, 2001.

Haley & Aldrich, 2002, *Site-Specific Background Metals Concentrations, Parcel C, Boeing Realty Corporation, Former C-6 Facility, Los Angeles, California.* January 4, 2002.

Kennedy/Jenks, 1996, *Phase I Environmental Assessment, Douglas Aircraft C-6 Facility, Parcel C, McDonnell Douglas Realty Company.* May 1996.

Kennedy/Jenks, 1997a, *Parcel A—Phase II Soil Characterization, Boeing Realty Corporation C-6 Facility.*

Kennedy/Jenks, 1997b, *Parcel B—Phase II Soil Characterization, Boeing Realty Corporation C-6 Facility.*

Kennedy/Jenks, 1997c, *Parcel C—Phase II Soil Characterization, Boeing Realty Corporation C-6 Facility.*

Kennedy/Jenks, 2000a, *Sampling and Analysis Plan, Boeing Realty Corporation's C-6 Facility – Parcel C, Los Angeles, California.* August 16, 2000.

Kennedy/Jenks, 2000b, *Addendum A of the Sampling and Analysis Plan.* September 12, 2000.

Kennedy/Jenks, 2000c, *Areas 4 and 5--Phase II Soil Characterization, McDonnell Douglas Realty Company, C-6 Facility.* August 22, 2000.

Kennedy/Jenks, 2000d, *Import Soil Screening Program Plan for the Boeing Realty Corporation Former C-6 Facility, Parcel C.* December 11, 2000.

Kennedy/Jenks, 2000e, *Site-wide Health and Safety Plan for the Boeing Realty Corporation Former C-6 Facility.*

Kennedy/Jenks Consultants, 2000f, *Groundwater Status Report, Boeing Realty Corporation's C-6 Facility, Los Angeles, California*, September 5, 2000.

Kennedy/Jenks Consultants, 2000g, *Groundwater Monitoring Work Plan 2001*, December 2000.
Integrated Environmental Services, Inc., 1997, *Health-based Remediation Goals for Surface Soils.*

Maness Environmental Services, Inc., 1994, *UST Removal, McDonnell Douglas Corporation, 19503 South Normandie Avenue, Torrance, California.* August 22, 1994.

Montgomery Watson, *Conceptual Design of Final Soil and Groundwater Remediation System at the Douglas Aircraft C6 Facility.* March 1994.

Ogden Environmental and Energy Services, Inc., 2000a, *Draft Technical Memorandum No. 1: Supplement to the Sampling and Analysis Plan.* December 14. 2000.

Ogden Environmental and Energy Services, Inc., 2000b, *Site-wide Soil and Waste Management Plan.*

Ogden Energy and Environmental Services, 2000c. *Site-wide Risk Assessment Work Plan for the Boeing C-6 Facility, Los Angeles, California.* November 29, 2000.

T & T Environmental Services, 1999, *Closure Report for the Abandonment and Removal of an Underground Fuel and Storage Tank at The Boeing Company, 19503 South Normandie Avenue,* Prepared for Perry Manes, Inc. Submitted to Los Angeles City Fire Department. January 12, 1999.

Tait & Associates, 1998, *Grading Plan, Boeing Realty Corporation, Harbor Gateway, Los Angeles, California, Sheets 5 through 10 of 12.* June 1998.

Tetra Tech, Inc., 1994, *Subsurface Soil Investigation at UST in Building 2 C-6 Torrance Facility.* September 1994.

U.S. Environmental Protection Agency, 1996. *Soil Screening Guidance: User's Guide and Technical Background Document*, USEPA Publication No. 9355.4-23.

U.S. Environmental Protection Agency, Region 9, 2000, *Preliminary Remediation Goals (PRGs).*

Woodward-Clyde Consultants, 1987a, *Phase I Underground Tank Leak Investigation Report for Douglas Aircraft Company's C6 Facility, Los Angeles, California.* June 1987.

Woodward-Clyde Consultants, 1987b, *Interim Report on Phase II of the Subsurface Investigation at Tanks 19T and 20T at the C6 Facility.* November 18, 1987.

Woodward-Clyde Consultants, 1987c, *Phase III Drilling Program at Douglas Aircraft Company's Torrance (C6) Facility,* December 16, 1987.

Woodward-Clyde Consultants. 1988a, *Final Report on the 8T Remediation at the Douglas Aircraft (C6) Facility.* March 4, 1988.

Woodward-Clyde Consultants, 1988b, *Final Report on Phase II of the Subsurface Investigation at Tanks 19T and 20T at the C6 Facility.* May 10, 1988.

Woodward-Clyde Consultants, 1988c, *Chromic Acid Soil Remediation at DAC C6 Facility.* May 13, 1988.

Woodward-Clyde Consultants, 1989, *Work Plan for Evaluation of Tank and Sump Locations With Organic Compounds in the Soil at the Douglas Aircraft Facility (C-6), Torrance, California.* February 7, 1989.